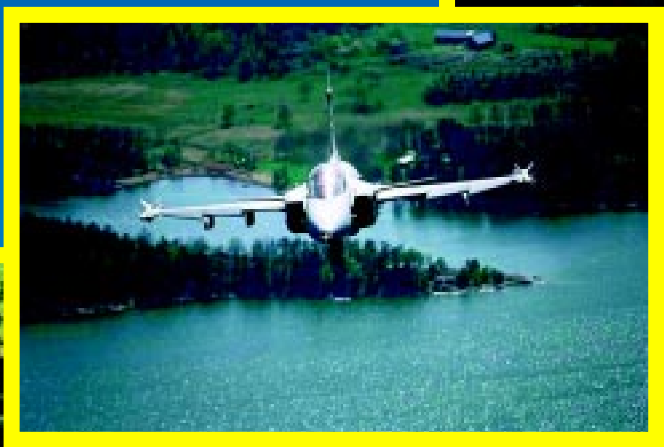
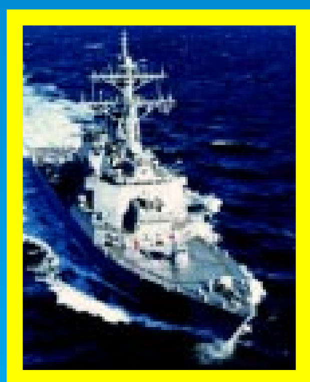
A joint publication of Sweden and the United States

Environmental Considerations in the Systems Acquisition Process



A Handbook For Program Managers



SWEDISH ARMED FORCES

Letter of Promulgation

This handbook is the result of a joint effort between the United States of America and the Kingdom of Sweden. It is a product of our "Agreement for Cooperation on Environmental Protection in Defense Matters."

The ideal time for understanding the interaction of new military systems with the environment and environmental regulations is at the beginning of the acquisition process. By incorporating environmental planning and pollution prevention into the design, we can minimize impacts on the global environment, reduce acquisition and life cycle costs, and optimize the ability to operate the systems worldwide without restrictions which may be imposed for environmental protection.

We believe that this handbook will be a valuable resource for the acquisition program manager and those participating in the acquisition of military equipment. It is based on the experience of the United States and Sweden and is intended to benefit militaries worldwide. A variety of systems and acquisition approaches are presented. We have included actual system examples as well as an overview of environmental management and planning tools.

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FOR THE
DEPARTMENT OF DEFENSE
OF THE
UNITED STATES OF AMERICA

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Washington, D.C., United States of America
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Environmental Considerations in the Systems Acquisition Process

A Handbook For Program Managers

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Preface

Military organisations throughout the world have a responsibility to their countries and the global community to operate in a manner compatible with the environment. The challenge is to develop weapon systems that minimise or effectively eliminate environmental impacts throughout each phase of their life cycle, yet fulfill the requirements of their purpose.

The United States and Sweden have co-authored this handbook to provide practical information to persons involved in the acquisition process on the environmental considerations and actions that may be taken to reduce the adverse environmental effects of military systems. We have compiled this book based on mutual experiences of active environmental protection work and have tried to make this knowledge generally applicable to the global community.

The key to the successful minimisation or prevention of future environmental impact is to consider environmental issues during the design phase of the system. Thus, clear guidance needs to be provided to weapon system program managers on the actions that are required to protect the environment. This guidance is not limited to consideration of the environmental laws and practices of the producing country, but also the environmental practices of all nations in which the system may be tested or utilised and to which the system may be sold.

With acquisition approaches ranging from "buy off the shelf" to total system development, there are many considerations and possible actions to minimise environmental impact. In addition, there are special environmental issues to consider for different types of weapon systems. This handbook describes the environmental issues associated with a variety of acquisition approaches and weapon systems, and discusses possible actions to mitigate environmental impact. It also offers useful ideas and suggestions on how to deal with environmental problems in a structured way.

Although the handbook applies to personnel at all levels in the acquisition process, it focuses primarily on the program manager. The manual should also be a valuable resource for military staffs, contractors, and specialists who are involved in the acquisition and purchase of military equipment.

The first four chapters are those that primarily apply to the program manager, military staffs, and contractors. Chapter 5 covers technical information for environmental experts on specific projects, and describes a collection of environmental analysis tools that assist the program manager in implementing an environmentally sound acquisition policy. References provided throughout this handbook are suggested reading materials for those who seek further information on this subject.

It is our wish that the contents of this handbook be widely spread to all it may concern. Therefore, permission is granted to reproduce, extract, or quote from this document, providing that the original source is given. In addition, permission is given to translate this document and publish such translations, providing that the source is referenced.

Hopefully, a higher degree of environmental awareness will emerge as a bonus effect of this work.

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Chapter 1: Statement of Ideals

The main task of each country's armed forces is national defence and protection of its interests. To meet that responsibility, the military sector must have weapons ready and personnel trained to use them. By necessity, actions to equip and train the armed forces will have some effect on the environment.

The impact of the defence actions extends over virtually all environmental problems, including greenhouse gases, ozone layer depletion, noise, waste and environmentally hazardous residues. The reason for this is that militaries conduct a wide range of activities and in many ways represent a cross-section of society. While a large part of this activity is specifically military, such as weapons training and military air traffic, many of these activities have clear counterparts in civilian society, such as heating of buildings and transportation using commercial-type vehicles.

The military sector should comply with the environmental policies and laws established for the rest of society, except in extreme circumstances. In addition, by acting in an environmentally responsible manner, the military sector is able to exert significant influence on the rest of society to do likewise. As a major purchaser, the armed forces should make demands on producers and encourage the development of environmentally sound products.

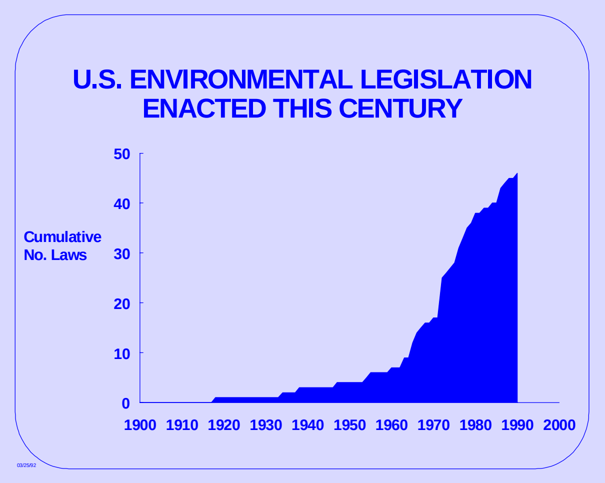


Figure 1.1: Growth of U.S. Environmental Legislation

Restrictions on the activities of the military sector have increased substantially during the last decades due to the growth of environmental legislation. The trend is international as well as national. The chart shown in Figure 1.1 illustrates the growth of U.S. federal environmental legislation.

The government must provide clear guidance to the military sector regarding its role in achieving national environmental goals and strategies. In most cases, the government would expect the same conduct on the part of the military sector as it has imposed on all other sectors. In support of the national environmental goals and strategies, the military should clearly define environmental goals that are specific to military activities. All staff members should be properly educated to be environmentally conscious and involved in environmental considerations.

Environmental considerations must be integrated in all activities. To guarantee this, an environmental management system (EMS) should be

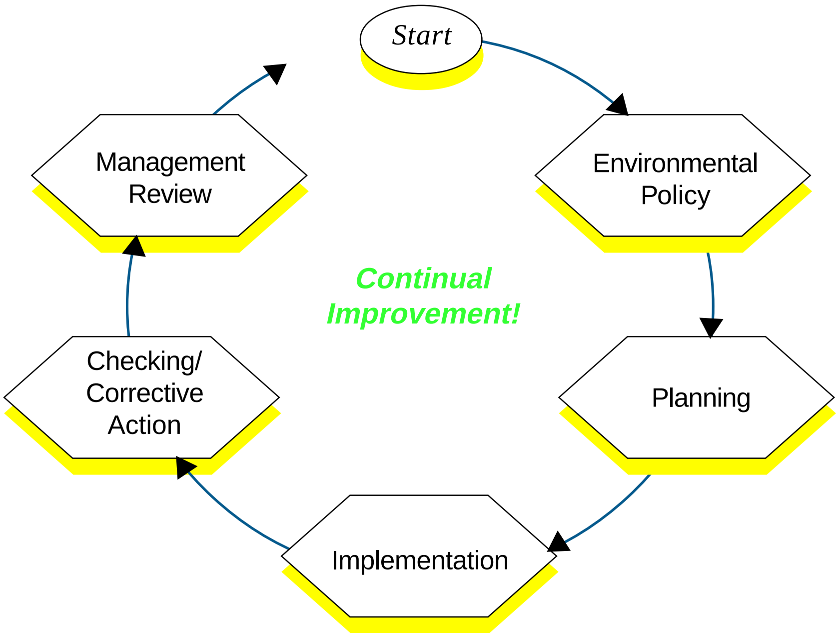


Figure 1.2: Basic Elements of an Environmental Management System

used. An EMS provides a systematic approach to plan, control, measure, and improve an organisation's environmental efforts. It is based upon the basic principles of planning, implementing, checking, and acting to correct deficiencies and improve performance. Chapter 5 contains a more detailed discussion of EMSs.

It is important that significant environmental consequences and problems are considered early in the planning process to allow sufficient time to consider alternatives, take different courses of action, or adopt strategies to compensate for unavoidable adverse consequences.

Early prevention is the most cost-effective way to handle environmental problems. The earlier you apply environmental considerations into the acquisitions process, the more money you will save both in the development and in the life cycle of the weapon system. Environmental costs can be substantial, sometimes increasing tenfold, if consequences are not considered early. By addressing potential problems early, the costs will be reduced and in some cases may be fully avoided.

Foresight and prevention of environmental problems will be even more critical in the future. At present, we do not know how future environmental legislation and other demands regarding the environment will develop, but they will most probably be more rigorous than those of today.

Most defence systems require special considerations because of their relatively long life cycles. This is in part due to lengthy development and production times and to long life spans—at the end of which, they often represent outdated technology.

The planning strategy for weapon systems involves the identification of military requirements and constraints, and the development of a suitable implementation plan.

In recent years, there has been a change in the manner of which weapon systems are developed. In the past, developers were concerned only with meeting the performance parameters specified by the future user and delivering the product at a specified price. Little attention was paid to the future costs to operate, maintain and dispose of the system. Those costs may represent more than 70% of the total life cycle cost of the system, including development and initial procurement. Weapon system managers in some countries are now required to consider the total life cycle cost at every decision point in the development of the system. As part of this cost, the full environmental consequences of the development, procurement, deployment and disposal of a weapon system must be carefully analysed before proceeding to the next phase of the program.

Many countries are now more sensitive to the costs and potential liabilities associated with the use of harmful materials. As a result, they require that the weapon system managers seek environmentally benign alternatives, both for new and existing systems, that still meet military performance specifications. Doing this at an early phase of development enhances the awareness of future costs and liabilities.

Weapon system managers must also reevaluate the maintenance and operations procedures prescribed in the manuals for existing systems. The rate of development and procurement of new weapon systems has decreased since the end of the Cold War. Accordingly, several older systems, which were developed long before the recognition of environmental problems, are expected to remain in service far into the 21st century. The maintenance and operations manuals for these systems require the use of hazardous materials that are responsible for considerable environmental costs and liabilities. Rather than accept those costs over the extended period of use, weapon system managers must seek, test, validate and adopt alternative, environmentally safe maintenance and operations practices.

Since military research and development budgets are constantly under constraint, every effort must be made to share technologies among nations. Joint development of weapon systems and other international programs will become even more necessary as environmental restrictions and demands are raised.

The search for environmentally safe processes and materials will benefit from increased international co-operation as well. Program managers and environmental engineers throughout the world are facing many of the same problems. In addition, the environmental damage caused by harmful materials or processes may not necessarily be confined within the borders of the country using them. There are many cases in which the release, either controlled or uncontrolled, of hazardous materials in one country has caused significant environmental damage in neighbouring countries. Consequently, all countries benefit from the expedited transfer of information on new, environmentally safe technologies or materials.

For a more comprehensive discussion on environmental work in the military sector, we refer to “Environmental Guidelines for the Military Sector,” a document from a joint Sweden-United States project (1996).

Chapter 2: Application of Environmental Issues to Weapon Systems

Following are some of the environmental issues that should be considered during design and acquisition of weapon systems to improve environmental compliance and cost-effectiveness. This chapter will cover the major environmental issues involved with the following system types: ships, aircraft, tactical vehicles and artillery, munitions, and electronics. Many weapon systems share similar consideration categories such as coatings, emissions, etc. As such, there is some overlap among the subsections of this chapter.

QUICK REFERENCE GUIDE
Systems Covered in this Chapter

Ships

Because of their missions, size, and complexity, ships are subject to a wider variety of environmental considerations than any other weapon system. To carry out their missions, navy ships may transit or operate in nearly every ocean and sea worldwide, from short trips out of homeport to deployments of six months or longer.

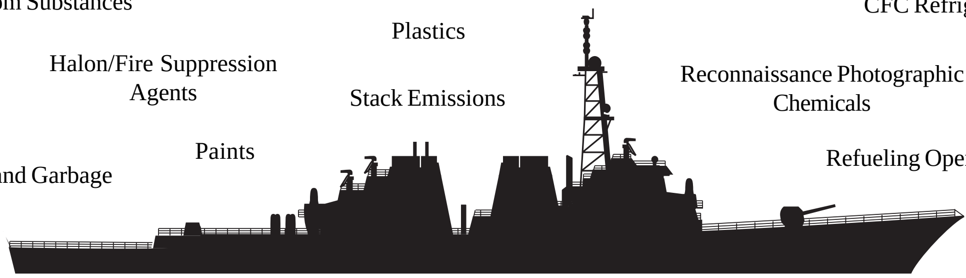
As a single weapon system, ships are incredibly complex, consisting of hundreds of major systems, thousands of subsystems, and millions of individual pieces of equipment. The waste stream from ships is equally complicated, with a large number of individual waste components. Each component has its own unique set of environmental issues. The environmental issues discussed below should apply to all ships; however, solutions may vary depending on many factors including ship mission and size.

Ships are the only type of system specifically regulated by international agreement. The International Convention for the Prevention of Pollution from Ships (MARPOL) was approved in 1973, and the final protocol was negotiated and amended by the International Maritime Organisation (IMO) in 1978. MARPOL does not apply to military warships; however, each government shall ensure that its ships act in a manner consistent with the Convention so far as it is reasonable and practical. MARPOL consists of four active annexes in force addressing Oil Pollution, Harmful Substances in Packaged Form, Amendments to Harmful Substances in Packaged Form, and Garbage. It is currently being expanded to include annexes on air emissions and other pollutants.

Graywater/Sewage

Ships with large crews generate significant quantities of graywater (drainage from showers, sinks, etc.) and sewage. While ships can hold limited amounts on board, in-port waste disposal costs can be prohibitive. Also, restrictions on discharge in coastal areas and in areas that bordering countries consider pristine may increase internationally.

VARIETY OF SHIPBOARD WASTE STREAMS



Presence of heavy metals or other contaminants may increase processing costs or cause permitting problems at receiving ports.

Source-reduction design methods such as waterless urinals, low-flow showerheads, and vacuum collection systems can help alleviate the problem. Systems such as ultra-filtration and thermal destruction of the resulting concentrate may be necessary to enable unrestricted operations in the future.

Oil/Oily Wastewater

Marine oil pollution will continue to be a sensitive issue worldwide. Oily wastewater is generated from sources such as drainage into bilges, cargo tank washings, dirty ballast, and seawater-compensated fuel systems. Discharge limitations for oily water in special areas designated by MARPOL and in most coastal areas are likely to become even more stringent and widespread. Like graywater/sewage, shore-based processing of high volumes of oily wastewater can be costly. Any improvements in propulsion and auxiliary plant equipment designs that minimise bilge drainage and oil content in ballast water should help alleviate this problem.

Foreign Organisms in Ballast Water

Transport and discharge of foreign (or non-indigenous) organisms or pathogens into coastal or inland waters via ballast water exchange, or via the anchor and chain, is a growing issue that has potentially grave ecological and economic impacts.

Since being introduced to the U.S. Great Lakes, zebra mussels have caused significant damage to the commercial fishing industry and local ecosystems.

The U.S. Great Lakes region and Australia have both incurred significant damage from foreign species introduced into their waters. Although voluntary guidelines and host country regulations are applicable primarily to commercial ships that frequently ballast and deballast in port, these guidelines should be taken into consideration for use as a matter of policy when amphibious warships operate close to shore.

Options that program managers should consider for minimising these problems may include designing ballast tanks with a limited number of longitudinal structure components to minimise sediment collection, or installing self-cleaning filters in ballasting systems to prevent the initial entry of sediment or organisms. Other possibilities are wash-down systems and auxiliary pumps to remove residual water. A system that washes organisms and sediments from the anchor chain as it is being raised, or one that permits access to the chain locker for chain cleaning and flushing, may also be necessary.

Solid Waste

Solid waste is generated by nearly every shipboard activity and is a ship's most visible and highest volume waste stream. An aircraft carrier can produce as much as 7,700 kg in a single day. Although coastal patrol boats generate much smaller quantities, they also have much less storage space. Like other waste types, overboard discharge is limited in coastal waters and in some International Maritime Organisation-designated Special Areas. In the future, even greater restrictions may be imposed. Imposing these restrictions on navy ships can cause significant problems if there are no feasible waste management alternatives.

An effective strategy for dealing with these issues would be a combination of source reduction and onboard processing. For example, effective use of information technology can reduce the quantity of paper in a ship's solid waste stream. The resulting reduced waste stream might be com-

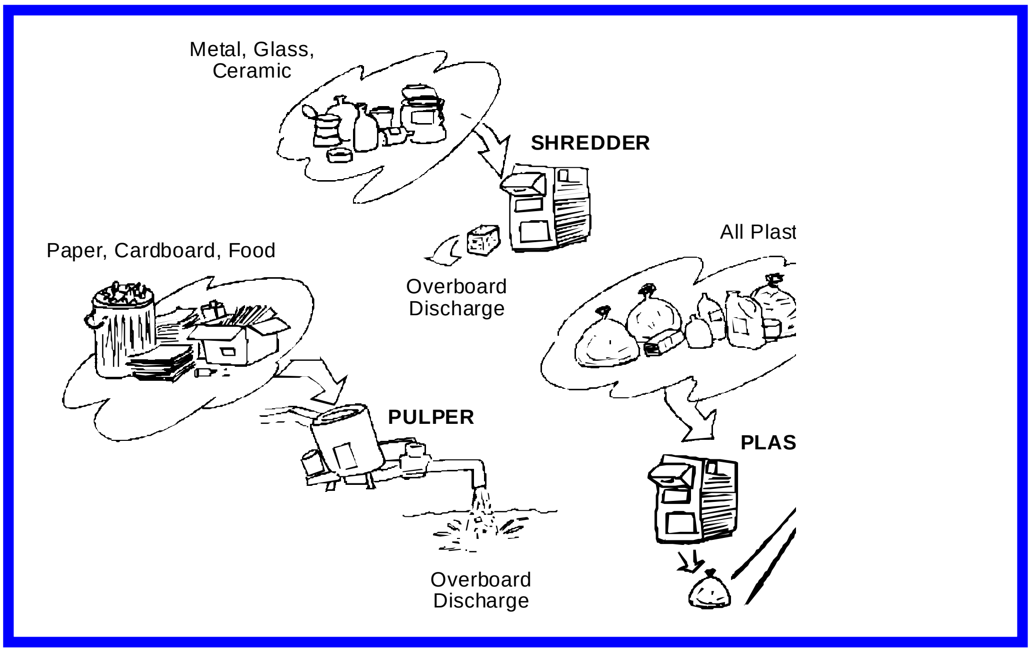


Figure 2.1: Examples of waste reduction and processing technology.

pacted on smaller ships or processed by some advanced technology. Destruction technologies such as advanced incineration or pyrolysis techniques are being researched, although air emission is an increasing international concern and may disqualify future candidates in this area. The cost of not designing waste management and handling capabilities into a ship up-front can be considerable. Examples of some waste processing equipment include paper and cardboard pulpers, metal and glass shredders, and plastics processors.

Marine Mammal Protection

Protection of marine mammals, particularly endangered whale species, is a significant concern. Some countries have instituted laws that prohibit activities that harass marine mammals, unless specifically authorised. The most immediate concerns for program managers are activities during ship testing and evaluation that could be construed as harassment, or other events that introduce energy into the water. Events should be planned to avoid testing in areas where marine mammals frequent, or planned with appropriate protection and mitigation.

Coatings

The extensive use of paints and other coatings is critical for corrosion protection in the marine environment, but may cause a wide range of short- and long-term environmental problems. Some paint contents may seem harmless when first formulated and approved for shipboard use, but later become expensive disposal problems, as well as a potential health risk. Past use of lead and chromate in paints and primers is a good example.

Coatings affect a number of different waste streams. Painting and paint removal is becoming an air emissions issue. Painting and stripping of ships in port can be a significant source of volatile organic compounds (VOCs), hazardous air pollutants, and particulates. As a result, these activities are being affected by permit regulations in some regions. Stripping techniques also create solid hazardous waste that must be stored on-board if the ship is at sea. Anti-fouling paints are used to keep ships' hulls free of marine organisms, but may leach into the water and create toxic conditions for marine life in surrounding harbours and estuaries.

Ships generate large quantities of paint-related waste just keeping corrosion in check. This can make up a majority of a ship's hazardous waste stream and can be a significant part of its operational budget. A program manager can decrease costs and mitigate environmental and health issues over the life of a ship by considering less problematic coating alternatives during initial construction, system design. Another issue is ensuring that space and equipment is available to allow ship crews to minimise generated paint waste.

Engine Emissions

Currently, a treaty is being negotiated by the International Maritime Organisation (IMO) to restrict air emissions from ships. MARPOL Annex VI (Air Emissions) will enter into force one year after the date on which 15 or more nations formally approve it, providing that those 15 nations constitute at least 50% of the gross tonnage of the world's merchant shipping fleet. IMO encourages formal approval by 31 Dec 2002 and will reconvene to review the treaty if it has not been approved by that date.

Again, MARPOL does not apply to any military warship. However, governments must adopt measures to ensure that their ships act in a manner consistent with the Convention so far as it is reasonable and practical. Therefore, program managers should be aware of the MARPOL standards and should include them in the design process where practicable.

Proposed restrictions will be defined in the following areas:

- Limits on sulphur content in fuel
- Control area limits on sulphur content
- Nitrogen oxides (NO_x) emission limits
- Ozone-depleting substances
- Hazardous material incineration

The most complicated portion of the treaty is the restrictions on NO_x emissions. Unlike sulphur oxides (SO_x) emissions, which are directly linked to the sulphur content in the fuel, NO_x emissions are very dependent on the combustion process. Engine manufacturers will find compliance with the new NO_x standards to be a challenge, as engine design will likely become the control mechanism for NO_x production.

Ship engines also emit carbon dioxide (CO_2), a greenhouse gas associated with global climate change. Emissions of greenhouse gases will be subject to increasing regulations in the future. In the Kyoto Protocol that was negotiated in December 1997, the IMO is assigned responsibility to reduce greenhouse gas emissions from ships.

Ozone-depleting Substances (ODSs)

As a result of the 1987 Montreal Protocol, a ban on the production of ozone-depleting substances (ODSs) went into effect for industrialised nations in January 1996. At that time, ODSs were used in virtually every weapon system. Systems use ODSs in three primary applications: air conditioning and refrigeration (CFC-l 1, CFC-12, CFC-114); fire suppression (halon 1211, halon 1301); and cleaning solvents (CFC-l 13, methyl chloroform (1,1,1-trichloroethane)). Alternatives for halon fire-fighting suppressants are being investigated and implemented where space and weight limitations allow. Substitutions have also been identified for most ODS solvents. In the future, weapon system managers will have to examine this issue even more closely as greenhouse gas regulations begin to take effect.

Medical Waste

Medical waste is a category of solid waste that has its own unique characteristics, hazards, and disposal issues. Most countries restrict the discharge of infectious medical waste from navy ships, including those wastes that could be considered to be infectious, such as hypodermic needles and other "sharps." Research and development of equipment to sterilise or render infectious waste safer for handling or discharge is ongoing and should be considered for integration into new ship design.

Hazardous Material (HM) Minimisation

A ship is a vast collection of mechanical, electrical, and electronic systems that use hazardous materials either during construction, maintenance, or operations. These can be as obvious as lubricants and solvents, or as hidden as the cadmium plating on a bolt. These substances can become costly issues during the life of the ship or upon demilitarisation and disposal. Recent examples have been efforts to eliminate ozone-depleting substances in response to international concerns, and difficulties performing sinking exercises due to the presence of polychlorinated biphenyls (PCBs) on older ships. Use of potentially toxic or carcinogenic chemicals during ship design should also be minimised to prevent long-term crew health and disposal problems.

Batteries containing lead acid are another hazardous material issue for ships (and submarines). The limited lifetime of batteries raises disposal issues as often as every five to eight years. Recycling of the materials and components is strongly recommended whenever possible. The example on page 54 provides more details on how the Swedes have addressed this problem.

During operation of ships, hazardous material supplies should be consolidated into a central dispensing area. In this manner the operator or maintenance person receives only the amount of material required for a particular task, thereby reducing both the amount of material needed overall and the amount of waste generated by unused material. Life cycle costs are reduced as a result.

Research is underway to find ways to decrease hazardous material used during construction, maintenance, and operation of ships in order to lower disposal costs and help shore facilities meet hazardous waste reduction goals. Although some solutions may be common sense and low cost, others may require expensive backfit for existing ships. It is far more cost-effective to minimise hazardous materials during initial design and construction. Although this can be a challenge for a weapon system as complex as a warship, the payoff will be decreased regulatory risk and dramatically lower operating and disposal costs.

Hazardous Waste Storage

Many of the previous paragraphs discuss processes that generate hazardous waste. This problem becomes unique in the shipboard environment, where waste must be safely stored until the ship reaches port and can off-load it. Some portion of the ship's limited storage must be allocated for the storage of hazardous waste. Additionally, off-load and processing of hazardous wastes is becoming increasingly difficult in overseas ports where support facilities may be non-existent. Large quantities of hazardous waste may have to be transported over large distances at significant cost and with risk of high-visibility spills or other accidents.

Port Requirements

The port requirements of ships can have significant environmental effects for both homeports and foreign ports. Facilities must be constructed and/or maintained to accommodate the physical size and support requirements of individual ships. Weapon system managers need to understand the impacts of requirements on the facilities in order to minimise impacts on the ports. Docks, replenishment facilities, and waste off-loading facilities may have to be constructed or altered to meet requirements of new systems, and harbours and channels may have to be dredged to accommodate ship draft. Maximum drafts can be specified during ship acquisition to eliminate additional dredging requirements. In foreign ports, further requirements may be levied on ships, especially concerning waste off-loading and discharge requirements. It is likely that these requirements will become more restrictive in the future.

Aircraft

Aircraft are a particularly mobile type of weapon system, operating from both land- and sea-based environments. Environmental issues range from operational emissions — such as air and noise — to maintenance and support issues, including material and processes used to paint/de-paint, plate, clean, and refuel the aircraft. The systems that are part of an aircraft usually consist of the following: the airframe itself, which includes the basic structure, electrical system, fire protection system, canopy and landing gear; the engine; the avionics; and the associated ground support equipment. The following paragraphs summarise some of the aircraft life cycle aspects that may cause environmental impacts.

Cleaning

The most prevalent maintenance process associated with aircraft systems is cleaning. The cleaning process is typically required before and after numerous other maintenance processes (e.g., composite repair, painting, plating, bonding, sealing, and inspection). Depending on the specific cleaning requirement, the cleaning compound can be solvent-based or water-based. Solvent-based compounds tend to perform better but are typically worse for the environment due to high concentrations of volatile organic compounds (VOCs). Cleaning compounds may also contain other hazardous air pollutants, may be flammable, and are likely to be hazardous to dispose of. To the extent practical, designing systems that are not required to be extremely clean can avoid the use of hazardous cleaning compounds. Such systems include those that avoid precision-designed components when appropriate or specify removal and replacement maintenance tasks instead of repair.

Aircraft and engine wash-down has additional concerns beyond parts and section cleaning. Aircraft and their engines must be regularly cleaned to remove soil, leaking fluids, and salt spray to prevent corrosion. Although mild detergent is usually used for this purpose, the wastewater it generates is contaminated with oils, fluids, and particulates from paints, coatings, plating, and metals.

Aqueous Parts Washer

The water must then be collected and treated depending on the contaminant particular to that specific aircraft. In cases where solvents are used for heavily soiled areas, this problem is increased significantly. Care should be taken to minimise the use of heavy metals and other hazardous substances in the design of the engine to avoid wastewater treatment issues during maintenance.

Painting and De-painting

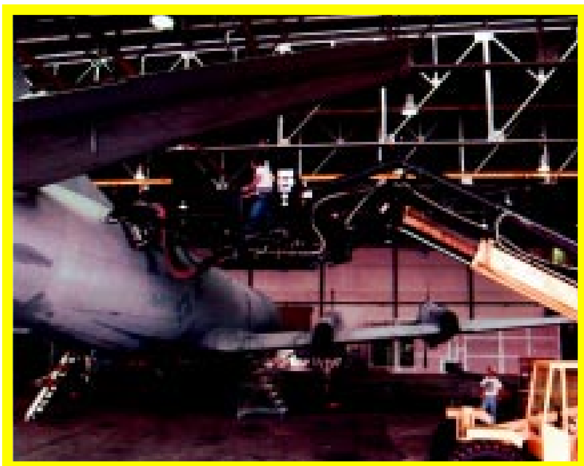
Aircraft typically are required to utilise numerous paint systems. In addition to exterior surface primers and topcoats, there are internal surface paint systems and coatings for special requirements such as increased erosion or temperature protection. The hazardous materials associated with the paint systems can vary, but they often contain heavy metals, VOCs (in the uncured state), and chemicals such as xylene and benzene. Both environmental agencies and occupational health agencies usually regulate these constituents. Due to the tremendous amount of painting required for aircraft, as well as the strict regulations on paint application processes, the costs associated with painting are significant.

The costs associated with de-painting are even more significant. Current mechanical and chemical paint-stripping practices involve the use of hazardous materials that, combined with the hazardous paint waste, result in significant disposal costs. Strict regulations are also associated with the removal processes, which have the potential for even more severe restrictions by the turn of the century. Complying with imposed restrictions translates directly into high costs and increased time. Avoiding exposure of operators and surrounding personnel, and capturing and treating effluents from operations before disposal necessitates significant developments, with the risk that developmental efforts may not produce satisfactory solutions. However, failure to succeed in avoiding exposure of operators and surrounding personnel — or in avoiding pollution — could translate into higher costs due to legal liabilities.

Paint should, therefore, only be specified when required for performance measures, not for cosmetic reasons. In addition, if a paint system is required, care should be exercised to select a system with the least impact to the environment during the application, removal, and disposal processes. Currently, several efforts are underway to produce less environmentally harmful paints and safer de-painting procedures. Other efforts are being made to eliminate or reduce the need for paints on the aircraft.

Inorganic Coatings

Other common aerospace materials include inorganic coatings, such as cadmium, chromium, nickel, and zinc — all of which have been linked to adverse health effects. Substitutions for cadmium and hexavalent chromium have been researched extensively depending on the application. Although the uses of these coatings should be minimised, there



De-painting of an aircraft.

are many applications where there are no life cycle issues associated with the coating beyond its initial application. Therefore, the life cycle of the component being plated should be evaluated to determine whether or not maintenance on the coating will be required, and whether there will be any disposal concerns such as leaching.

Hazardous Materials

In addition to the organic and inorganic coatings discussed above, aircraft systems utilise substantial amounts of other hazardous materials. Some of the most common hazardous materials are found in sealants, adhesives, petroleum products, and synthetic lubricants and fuels, cooling and de-icing fluid, and batteries.

Sealants and adhesives generally are regulated due to their volatile organic compound (VOC) content and their corrosion-inhibiting compounds. Design alternatives can minimise the requirement for some uses. In addition, new formulations have reduced VOC levels and less hazardous constituents.

Used petroleum products and synthetic oils and fluids are generally hazardous to dispose of, depending on their contamination and various regulations. Fortunately, there are processes available to recycle and reuse many of these products. A specific concern with some solid-film lubricants has been lead content. Lubricants with a high lead content should be avoided whenever possible. A diesel fuel concern has been the sulphur content. Many types of ground support equipment utilise diesel engines, which produce significantly higher sulphur emission when using high sulphur fuels. Low-sulphur fuel is the preferred alternative.

Ethylene glycol products are frequently used in many equipment cooling applications as well as in de-icing processes. In the cooling applications, there is generally little environmental impact due to the availability of recovery and recycling equipment. Unfortunately, the de-icing process can cause adverse environmental impacts because it is highly toxic to aquatic and mammalian organisms. Possible discharge control methods include runoff-mitigating structures, treatment facilities, detention basins, underground storage tanks, and recycling of the glycol fluids. Each of these options has advantages and disadvantages that must be weighed to determine the best alternative for each situation. Currently, there does not seem to be a readily available technology that can take the place of the current materials and processes. Although propylene glycol is a preferred alternative to ethylene glycol because it is less toxic, propylene glycol still has disadvantages (e.g., it degrades at a slower rate and consumes more oxygen while it is being broken down). Other materials are currently being researched and tested to develop a less environmentally harmful alternative. Another possible solution is to design the aircraft system with on-board surface-heating systems that eliminate the requirement for de-icing. This alternative is not conducive to all aircraft systems; therefore, alternative de-icing procedures or materials still need to be identified.

Hazardous Waste

Many of the aircraft processes described here create hazardous waste streams that must be separately stored, treated or disposed. Much of an aircraft's solid waste generated is from de-painting waste and used solvents. Where possible, solvents should be recycled and the least hazardous acceptable option should be used. For de-painting, technologies such as media blasting or flashjet should be investigated and used where feasible. Other technologies such as media blasting pellets can be reused and recycled, reducing the amount of waste generated from the process. New appliqué technologies for aircraft coatings are also being investigated. These appliqués may eventually replace paints and resolve many of the painting and de-painting issues. New aircraft programs should investigate this option as the technology advances.

Noise

Aircraft noise is an environmental issue that, when not adequately mitigated, can significantly deteriorate the relationship between the mili-

tary and surrounding communities. The issues associated with aircraft noise consist of the impact on the surrounding communities and wildlife, as well as the impact on aircraft pilots and maintenance crew. Some countries impose direct regulations on military aircraft noise; others do not. Even when national governments do not directly regulate the noise emissions from the engine, there are usually other regulations or policies related to aircraft noise. Examples include regional and local laws that prescribe maximum noise levels across property lines, occupational health requirements to protect personnel from excessive decibel levels, and restricted flight operations by location, duration, and time of day.

To reduce noise impacts, low-noise-emission products should be procured whenever feasible. Other noise mitigation alternatives consist of sound-suppression equipment and sound barriers when developing new aircraft-related systems such as engine test stands, and procuring suitably quiet associated ground support equipment (e.g., starters and hush houses) for new jet or other aircraft systems.

Engine Emissions

While there are currently no specific international restrictions on the engine emissions from military aircraft, program managers should understand the impacts that military aircraft have on local air quality problems. Engine performance requirements influence pollutant emissions.

Unlike sulphur oxides (SO_X) emissions, which are most affected by the levels of sulphur in fuel, nitrogen oxides (NO_X) emissions directly increase with raised performance levels. When establishing requirements for aircraft engines, consider the effects of performance level on air emissions. This concept can be included in an aircraft's performance and design specifications, which should define specific emissions goals for different power settings.

Aircraft engines also emit carbon dioxide (CO_2), a greenhouse gas associated with global climate change. Emissions of greenhouse gases will be subject to increasing regulations in the future. In the Kyoto Protocol that was negotiated in December 1997, the International Civil Aviation Organisation (ICAO) is assigned responsibility to reduce greenhouse gas emissions from aircraft operations. In the future, ICAO will likely pursue new engine technologies for civil aviation to reduce greenhouse gas emissions, along with improvements in operational procedures and air traffic control systems.

Ozone-depleting Substances (ODSs)

Up until 1996, ODSs were used in virtually every weapon system. Since then, the 1987 Montreal Protocol as gone into effect, banning the production of ODSs by all industrialised nations. Weapon systems use ODSs in three primary applications: air conditioning and refrigeration (CFC-l 1, CFC-12, CFC-114); fire suppression (halon 1211, halon 1301, halon 2402); and cleaning solvents (CFC-l 13, methyl chloroform (1,1,1-trichloroethane)). Most cleaners and solvents have non-ODS substitutes identified, but weight and space limitations have made it more difficult to replace halon fire-suppressants on aircraft. Inert gas generation systems and non-ozone-depleting fluorocarbon suppressants are in development for new aircraft, which should eliminate Class I ODSs completely from these systems.

Tactical Vehicles and Artillery

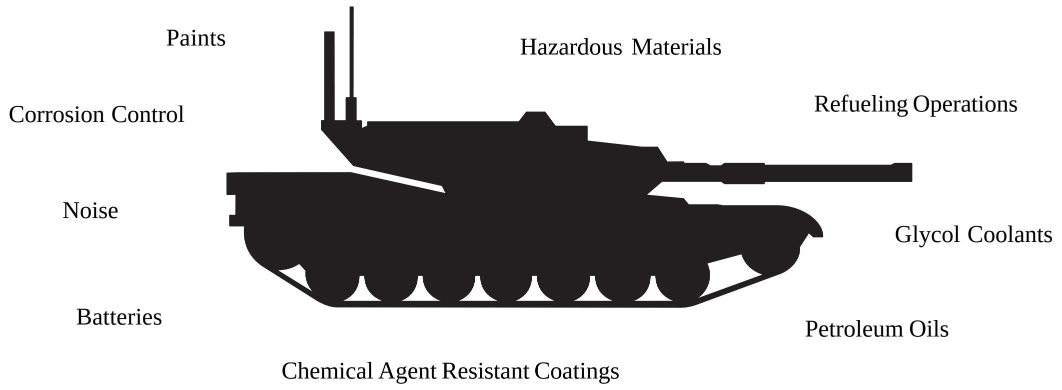
Although some tactical vehicles are amphibious in nature, most operate over land. Hence, the majority of their environmental impacts relate to operation over training grounds and scheduled maintenance at military facilities. Like the weapon systems already discussed, tactical vehicles face common environmental issues resulting from the hazardous materials associated with fuelling, painting, fire suppression, etc. However, operation of the vehicles also creates significant land management issues due to land degradation, fluid leaks, and noise.

Hazardous Materials

Typical hazardous material usage includes primers, paints, adhesives, sealants, solvents, petroleum products, chromium and cadmium. Although most of these hazardous materials are similarly used on aircraft, there are certain instances where the use on tactical vehicles may pose more of a potential risk to the environment. When not flying, aircraft are usually parked in areas where oil or fuel leaks can be contained. Vehicles almost always operate directly over natural media, so any leaks will cause direct contamination of the ground area. The overall impact to the environment depends on the degree of leaking, the number of vehicles, and the type of ground and area in their operating environment.

Operation and maintenance of tactical vehicles requires a large degree of flexible, transportable resources. Their continuous operation requires on-site availability to petroleum fuels, tank storage and fuel farms, which increases the risk of leaks and spills. Ethylene glycol products are frequently used in many equipment cooling applications. Although propylene glycol is a preferred alternative to ethylene glycol because it is less toxic, propylene glycol still has disadvantages. For example, it degrades at a slower rate and consumes more oxygen while it is being broken down. Recovery and recycling equipment greatly reduces the environmental impact of these chemicals as well as reduces maintenance supply costs. The scheduled maintenance of these vehicles requires changing motor oil and coolants every 4,800 to 8,000 kilometers. With a fleet of tactical vehicles, these actions create a large surplus of used oil and ethylene or propylene glycol. The volume of these fluids, which must then be disposed of as waste, can be significantly reduced through treatment and recycling.

VARIETY OF TACTICAL VEHICLE WASTE STREAMS



Land Management

An even more significant issue associated with environmental impact to land and natural resources is a result of testing and training with the tactical vehicles. Heavier and faster vehicles, longer combat engagement distances, and increases in mechanisation and combined arms exercises have all made the need to maintain realistic training areas a crucial land management issue. Over-utilised or poorly managed lands quickly degrade and become barren and gullied. Once this happens, they cannot support realistic training.

Land management plans should address soil and water conservation, wetlands and floodplains, grounds maintenance, agricultural uses, and fire management. Land management must also reflect good economics. For instance, costs for maintaining grounds should be minimised by providing the least amount of mowed areas and special plantings necessary to accomplish management objectives. Program managers should ensure that the testing and training requirements for newly developed tactical vehicles are co-ordinated through the operations and training personnel responsible for facility land management.

The top photo shows an over-utilised tank training range. The photo below shows the same range with appropriate land management.

Paints/Coatings

In addition to exterior surface primers and topcoats, there are internal surface paint systems and coatings for special requirements such as increased protection from erosion or temperature extremes. The hazardous materials associated with the paint systems can vary, but they often contain heavy metals, volatile organic compounds (VOCs), and chemicals such as xylene and benzene, along with a host of other hazardous materials. Both environmental agencies and occupational health agencies usually regulate these constituents. The costs associated with painting are significant. Paint should therefore only be specified when required for performance measures, not for cosmetic reasons. In addition, if a paint system is required, care should be exercised to select a system with the least impact to the environment in the application, removal, and disposal processes.

Tactical vehicles also have more complications than systems with specific repair facilities, such as a paint booth to control the associated VOC and other air emissions. During field operations of tactical vehicles, these facilities are seldom available, thereby prohibiting spot repair of paints and coatings in some regions. Repair delays increase the risk of corrosion on the systems.

Most tactical vehicles are also required to have coatings of Chemical Agent Resistant Coating (CARC). This coating must achieve rigorous performance standards to protect soldiers in wartime, meet camouflage requirements, and comply with various air pollution regulations. Several research projects have developed water-based, low-VOC CARC coatings that may be safely used during maintenance of these systems. These projects are currently being tested for durability in the field and should be considered during tactical vehicle system acquisition.

Noise

Numerous groups are concerned with noise issues associated with tactical vehicles and guns during training exercises. These groups include the surrounding community, installation command, and master planning and environmental offices at every level in and above the installation. Community response to noise produced during military training and testing has had a significant impact on training facilities, schedules, and the operation of test ranges. Entire missions have been curtailed or moved because of noise impacts on the surrounding community. Community response to blast noise and sonic booms was compared in recent studies. The results of these studies are being used to refine current models used to predict the response of surrounding communities to a combination of military noises. More accurate prediction of the community response to noise will permit the military to maximise the use of its training and testing facilities.

When considering the sounds of guns, it is common sense to expect that the most powerful gun will make the biggest bang, and, in general, this is true. Other noise factors are design features, which shape the level and spectrum of the gun blast. For the gun tube, these include tube directivity, charge size, tube length, muzzle shape and calibre.

Three sources of gun noise are evaluated during noise studies: propellant blast, target blast and ballistic wave. All weapons generate a propellant blast. As the size of the gun increases, two changes occur: the decibel level increases, and the dominant sound frequency decreases (so that the “crack” of the rifle becomes the “roar” of the cannon). When a projectile travels faster than sound, it causes a tiny “sonic boom” known as the ballistic wave. A number of weapons, both small and large, generate a ballistic wave. If the projectile contains an explosive, there will be an explosion at the target. As the amount of target explosive increases, the decibel level increases and the dominant sound frequency decreases.

Evaluating the environmental impact of gun sounds is very complex. People living near military firing ranges may be annoyed for two reasons. First, they hear the guns and do not like the sound. Second, the guns shake their houses and they do not like the rattles. To evaluate both sources of annoyance, the military measures noise in two ways. For small guns, such as rifles and pistols, the measure quantifies the loudness of a sound. For large guns or explosions, such as mortars, howitzers, tanks and cratering charges, the measure is for both the audible sound and the less audible low-frequency sound responsible for house vibration.

There is a NATO Working Group concerned with the effects of firing noise on humans, structures, and animals. Although there is a fair amount of data on how aircraft noise affects animals, there is little information about the effects from weapons noise. European and U.S. militaries are concerned, since endangered species thrive in training areas.

Engine Emissions

Most modern diesel engines are turbocharged and intercooled to maintain good fuel consumption and low-exhaust gas emissions. However, they still have air emissions issues that should be addressed. There are five main emissions from diesel engines: nitrogen oxides (NO_x), hydrocarbons (HC), carbon monoxide (CO), particulate matter (PM), and sulphur dioxide (SO_2) emitted in the form of black smoke.

Unlike SO_x emissions, which are most affected by the levels of sulphur in fuel, NO_x and CO emissions will directly increase with increased performance levels. PM is a problem more common to diesel engines, as these particles are coated with condensed HC. Vehicle engines also emit carbon dioxide (CO_2), a greenhouse gas associated with global climate change. Emissions of greenhouse gases will be subject to increasing regulations in the future.

Program managers should understand the impacts that their systems will have on local air quality problems. Diesel technology is being developed with an emphasis on increased performance with a reduction in the level of air emissions.

Ozone-depleting Substances (ODSs)

The 1987 Montreal Protocol banned the production of ODSs by industrialised nations effective January 1996. At the time the ban went into effect, ODSs were used in virtually every weapon system. Systems use ODSs in three primary applications: air conditioning and refrigeration (CFC-l 1, CFC-12, CFC-114); fire suppression (halon 1211, halon 1301, halon 2402); and cleaning solvents (CFC-l 13, methyl chloroform (1,1,1-trichloroethane)). While substitutes have been identified for most ODSs used in solvents and cooling systems, many current and developmental tactical vehicle systems continue to use halons in their fire and explosion suppression systems. Substitutes are being investigated for use in these systems.

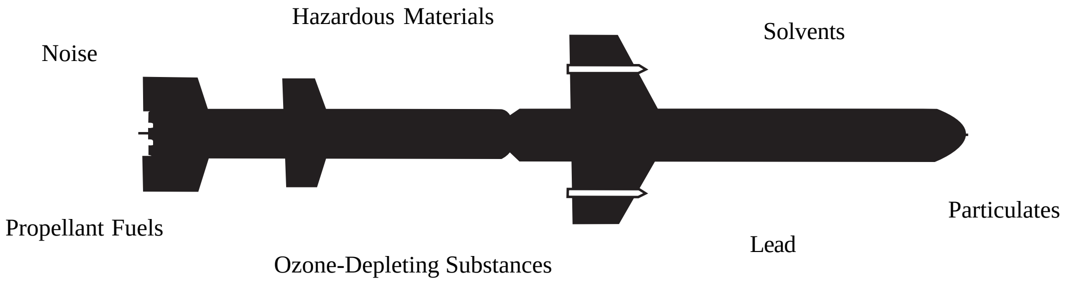
Batteries

Land vehicles and associated equipment often use various types of batteries containing toxic substances and other environmentally hazardous materials. When little charge is remaining, some types of batteries may no longer be considered hazardous because only a small concentration of toxic material remains in them. The charge can usually be determined using a battery test set; if the charge can not be determined, the battery should be considered hazardous.

Federal regulatory agencies have reduced the regulatory burden on battery disposal by advocating materials to be recycled by use, reuse, or reclamation. Some examples of battery recycling methods and other regulatory efforts include:

- reclaiming spent lead-acid batteries;
- recovering precious metals (e.g., silver) in batteries
- returning used batteries to the manufacturer for regeneration;
- phasing out mercury-containing batteries;
- developing efficient and cost-effective means of collecting and recycling cadmium-containing batteries; and
- implementing national and uniform systems for labelling batteries.

VARIETY OF MUNITIONS WASTE STREAMS



Munitions

While less complex than weapon system platforms, the weapons themselves have distinct environmental issues. Munitions are inherently destructive during operation; however, environmental impacts can be lessened for manufacturing, weapons testing, training, and eventual disposal of the system. Minimising impacts of peacetime operation is critical for the continued use and cleanup of military ranges.

The term munitions includes propellants, explosives, pyrotechnics, chemical and riot control agents, smokes, incendiaries (flares), chemical munitions, rockets, missiles, bombs, warheads, mortar rounds, artillery and small arms ammunition, grenades, mines, torpedoes, depth charges, cluster munitions and dispensers, demolition charges and devices, and their components.

Because many types of munitions are developed for a variety of weapon systems, environmental impacts vary depending on the use of the munitions and types of hazardous materials used as ingredients. Generally, munitions held in storage or placed in a weapons system pose minimal threat to the environment, as these systems require little if any maintenance. Environmental impacts most likely occur during manufacturing, testing, evaluation and training operations, or as a result of the demilitarisation and disposal process.

Manufacturing

During the manufacturing process, the major problem is in the hazardous materials used and the air emissions produced by the various manufacturing techniques. These substances include lead, antimony, barium nitrate, methyl ethyl ketone, toluene, xylene, and other restricted substances. Where solvents are used, air pollutants can be released into the atmosphere. Closed-loop solvent processing can eliminate these emissions in some cases. Solvent recycling also reduces the amounts of waste produced during manufacturing.

Operations

During testing, evaluation, and training operations, potential impacts to the environment include the generation of hazardous waste, increased noise levels, mobile air emissions, and contamination of soil and groundwater. In addition to soil particles introduced to the atmosphere by impact, gaseous emissions are released both when the weapon is fired and as it explodes. Muzzle release gases include such pollutants as carbon dioxide, carbon monoxide, nitrogen oxides, and in some cases, hydrogen chloride. Similar gases are released upon impact of various munitions with the addition of methane, ammonia, aluminum oxides and carbon particles.

The remaining fragments of fired munitions are embedded in the range, contaminating the soil and possibly leaching into the groundwater. Soil residues include carbon, and metals such as iron, aluminum, copper, tungsten, depleted uranium, and lead. These contamination issues will increase as military forces rely more on "smart" weapons, adding electronics issues to the pollutants previously mentioned. While circuits and wiring boards introduce some plastics and additional metals, the primary issue is usually the batteries, which introduce acids and heavy metals to the soil. Testing of munitions that include cadmium batteries is prohibited over some open-water ranges in sensitive marine areas, and this trend is likely to increase in the future. Program managers should develop test plans that require minimal use of test items to avoid the disposal of excess items. They should also ensure that test ranges comply with all test requirements, and that training requirements are coordinated through the persons responsible for the facility's range management.

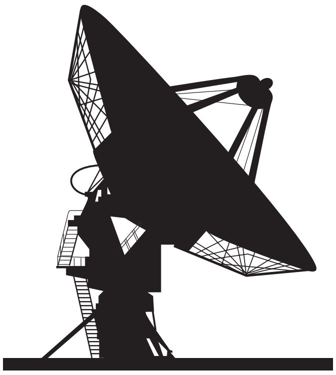
Range management is becoming an important environmental issue, and restrictions are being placed on how testing will be done to minimise impacts to the soil and groundwater. A major issue is the amount of lead being introduced to the soil by various munitions detonated in a concentrated area. The lead enters the groundwater and runoff, and can contaminate local water supplies. On small arms ranges, this impact can be reduced using bullet traps, which increase recycling opportunities for spent ammunition. Several projects are in development to reduce or eliminate lead and other hazardous substances from artillery and small arms ammunition.

Demilitarisation/Disposal

During the life cycle of a weapon system, most munitions will enter the demilitarisation and disposal process due to damage, failure too costly to repair, excess surplus, or because the item is obsolete. Demilitarisation includes disassembling the munitions item for recycling, reclamation, or reuse of the components. Composition, size, weight, and geometry determines whether component recycling or reclamation is a viable alternative to disposal.

Potential impacts to the environment during the demilitarisation/disposal process include mobile air emissions, soil or groundwater contamination, and the generation of wastewater or sludge. Open burning and open detonation have been used for decades as the primary means of munitions disposal, but more restrictive environmental initiatives may further limit or prohibit those means altogether. Alternate technologies designed to minimise impact to the environment are being investigated. Program managers should consider environmentally friendly material alternatives and alternative demilitarisation and disposal technologies when developing new munitions. Specifically, new munitions initiatives should be designed to make components easier to recycle at the end of their life cycle.

VARIETY OF ELECTRONICS WASTE STREAMS



Electronics

Electronics and avionics are often developed in association with weapon system platforms and should be evaluated as a subset of the overall system. However, the electronic subsystems themselves have unique environmental impacts, especially related to manufacturing and disposal of the system.

Packaging

Plastics are by far the most commonly used form of packaging for integrated circuits and the outer shells of electronic systems. Plastic packaging creates less waste than other forms, but still requires epoxies, heavy metals and flame-retardants. The presence of these hazardous materials complicates recycling efforts for electronics. Ceramics are the next most popular form of packaging. While they require much less set-up for the circuit manufacturer, they are heavier, more expensive, and they generate more waste than plastics. Processing of ceramic packages requires more chemicals, more energy, and the use of carcinogenic materials, thereby increasing environmental risks for the manufacturer.

Printed Wiring Boards

Wiring boards use a number of hazardous materials during processing, including plating chemicals, lead solder, etchants, imaging chemicals, and solvent cleaners. To some extent, chemicals used during production can be replaced by less hazardous substitutes. Aqueous developers can replace solvent developers; cleaning processes can be eliminated or replaced with less hazardous cleaners. Solvents used in plating and etching can be recycled; however, technology needs to be developed to support these changes. There is currently no acceptable alternative to lead solder, although research programs are addressing the problem.

Displays

There are two main types of displays: cathode ray tube (CRT) and flat panel. CRTs provide a rich, high-resolution display. Flat panel displays are more suited to applications that have space and weight limitations.

The manufacturing of CRTs involves similar problems to the packaging concerns previously described, including plastics, solvents, and other hazardous materials. In addition, CRT manufacturing features a number of unique environmental issues, such as glycol coolants and leaded glass components. Leaded glass creates a problem for disposal of the units, complicating recycling efforts. Lead can leach from components during the recycling process, which involves crushing of the glass. This crushing also creates a lead-contaminated dust, which can endanger the safety of workers. Industries need to develop alternatives to leaded glass components, as well as develop better methods of

Air traffic controller aboard the USS George Washington (CVN 73)

recycling leaded glass.

Flat panel displays are still considered a developing technology, and there has been little pressure on industry to design a more environmentally friendly product. While the flat panel displays eliminate the lead problems associated with CRTs, they do involve several hazardous materials during processing, including photolithography chemicals, acid etchants, cleaning solvents, and heavy metals. Efforts have been made to eliminate and recycle solvents used in processing, thereby reducing air emissions. Research is also being conducted to find more environmentally friendly processes for etching, lithography, and cleaning.

Design for Reuse

Although a relatively new concept, the electronics industry is attempting to incorporate the issue of future disposal efforts into the design of displays and other electronic equipment. Designers are making the components easier to separate from the original system. Unlike mechanical systems, electronic components do not usually wear out, but are instead replaced by newer and better technologies. The cost of electronics makes the reuse of these components an attractive idea to manufacturers. Manufacturers are currently trying to find a way to make use of the growing market of outdated computers and components. As restrictions on disposal of these systems increase, this trend is likely to gain even more popularity.

Fully Flourinated Compounds

Fully fluorinated compounds such as perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) are used in a variety of applications in military electronics. Both PFCs and SF_6 are considered greenhouse gases and have extremely long atmospheric lifetimes, resulting in possibly irreversible accumulation in the atmosphere. Program managers should be aware of the negative impacts of the use of these chemicals and minimise their use where possible.

Although about 80% of the worldwide use of SF_6 is as an insulator in electrical transmission and distribution systems, it is also used as a radar waveguide pressurisation gas in military air station traffic control radars. Similarly, PFC-116 (C_2F_6) is also used as a waveguide pressurisation gas in many search radars found on aircraft such as the P-3C Orion patrol aircraft, the SH-60B multipurpose helicopter, and the S-3B Viking antisubmarine warfare aircraft.

In addition to waveguide pressurisation uses, PFCs have been in use since the 1960s as cooling fluids in direct contact with high power electronic components or as heat transfer fluids in recirculating electronic component coolers. PFCs are used in this application in many military radar transmitters, electronic power supplies, lasers, and supercomputers.

Finally, PFCs are commonly used in electronics manufacturing for vapour phase re-flow soldering. In this application, the PFC liquid is heated to boiling in a vapour phase soldering unit. As a printed circuit board with pre-applied solder enters the vapour zone of the boiling PFC, saturated vapour condenses on the surface and gives up its latent heat of vaporisation. This heat causes the pre-applied solder to soften and re-flow around components that have been placed on the circuit board. As the board cools in a cooling zone, the PFC evaporates and the solder joints harden.

Chapter 3: Co-operative Armament Programs

An early and fundamental military acquisition decision that all program managers must make is whether to develop a new weapon system, to modify an existing system, or to purchase a system already developed by others. The cost to develop and produce weapon systems has increased exponentially over the last 40 years, which has influenced governments to seek alternative, more cost-effective approaches. Similarly, the complexity of systems has also increased significantly. This makes it difficult for most countries to maintain a state-of-the-art knowledge base in all weapon system technologies. Therefore, when considering "new starts" for acquisition programs, the general order of preference is:

1) use or modification of an existing domestic military system;
2) use of a non-developmental item or a foreign system;
3) development of a co-operative system with one or more participating nations;
4) development of a new multi-service system; and finally
5) development of an entirely new service, unique system.

Developing a weapon system co-operatively with another country provides an opportunity to improve the system's affordability and quality throughout its life cycle. This chapter is intended to provide insight into incorporating environmental considerations in developing, acquiring, operating, and maintaining and disposing of systems and components internationally.

Background

The start of the Cold War limited international military co-operation. As countries struggled to rebuild their production capability, each country's government demanded that weapon systems be of domestic design, development and production whenever possible. The result was limited compatibility in joint military operations, which created a logistics nightmare when trying to address each system's unique support requirements when operating.

During the 1970s and 1980s, many countries' defence ministries began establishing policies that emphasised co-operation in equipment acquisitions to improve military effectiveness and to provide economic and industrial opportunities for all participant countries. These co-operative efforts have proven to be a cost-effective means to pursue weapon systems of mutual interest, to pool shrinking defence resources, to improve interoperability, and to help sustain each nation's industrial base. During this same period, many governments began to pass aggressive domestic environmental legislation, which was the beginning of some major divergences between the environmental requirements of various countries.

Types of International Co-operation

There are many different forms of international co-operation for defence technologies. They include, but are not limited to, co-development, collaboration, co-operative research and development, co-production assembly, joint ventures, licensed production, mergers and acquisitions, strategic alliances, teaming and sales. Some of these forms of co-operation are government-to-government, industry-to-government, or industry-to-industry.

Government Co-operation

Co-operative armament programs are common for both large and small countries. For example, in 1996, the U.S. military had 50 co-production programs with 19 different countries. The U.S. also had a number of co-development and co-operative research and development programs. European countries have also made progress in developing and implementing unified armament initiatives. European officials see the more unified European defence market as crucial to the survival of their defence industries. The individual national markets are considered to be too small to support an efficient industry, and the mergers and consolidations of U.S. defence companies are generating concern about the long-term competitiveness of a smaller, fragmented European defence industry.

In 1996, two different European armament agencies were formed, the OCCAR (Organisme conjoint de coopération en matière d'armement) and the Western European Armaments Organisation (WEAO). OCCAR was formed as a management organisation for joint programs involving two or more member nations. OCCAR's goals are to improve efficiency in program management and to facilitate emergence of a more unified market. The WEAO's purpose is to promote European armament co-operation, strengthen the European defence technology base, and create a European defence market. WEAO also has legal authority to administer contracts. Both organisations are in a position to address the environmental requirements of

The Joint Strike Fighter: An Internationally Developed Weapon System

The Joint Strike Fighter (JSF), a U.S. multi-service developmental program, has the following four levels of involvement for international participants:

- Collaborative Development Partnership – Full partners within a Memorandum of Understanding (MOU) framework with the ability to influence requirements.
- Associate/Limited Partnership – Limited partner within the MOU framework, and limited participation in specific technologies or core program with limited ability to influence requirements.
- Informed Partner – Allowed access to information on JSF requirements to allow them to understand and evaluate the utility of the JSF family of aircraft for their use, but unable to influence the requirements.
- Fee for Service – Foreign industry provides technical expertise or contributions in exchange for payment, and subcontractors to the U.S. prime contractors.

Lockheed Martin Conceptual JSF

For the JSF, the United Kingdom Royal Navy is a full Collaborative Development Partner for the Concept Development Phase; Denmark, Norway and The Netherlands are participating at the Associate Partner Level; and Canada is expected to participate as an Informed Partner.

Boeing Conceptual JSF

Eurofighter 2000

participating countries in multi-national procurements.

The European Union (EU) is also a significant leader in addressing environmental responsibility. The EU established its first draft specifications for environmental management systems (EMSs) in December 1990. This EMS standard (explained in more detail in chapter 5) provides some environmental management and performance consistency among European defence manufacturers who voluntarily implement it.

Industry Co-operation

In addition to the European governments, the European defence industry is increasing co-operation. Many industries have consolidated and restructured through national and cross-border mergers, acquisitions, joint ventures, and consortia. Restructuring examples include: France's Thompson CSF and Aerospatiale regrouped their avionics and flight electronics activities and formed Sextant Avionique, and Germany's Deutsche Aerospace became Daimler-Benz Aerospace.

Individual European companies have long histories of co-operative armament programs for the development and production of large complex weapon systems. For example, major aerospace companies from the United Kingdom (British Aerospace), Germany (Daimler-Benz Aerospace), Italy (Alenia), and Spain (CASA) have created a consortium to work on the Eurofighter 2000 program. These same companies, with the addition of Aerospatiale, have also established a co-operative venture in the development of the European military transport aircraft known as the Future Large Aircraft. Through company mergers, acquisitions and joint ventures, there is an exchange of manufacturing technologies and processes. This information exchange is an opportunity for sites within different countries to compare environmental compliance requirements and share product and material/process improvements.

Foreign Sales/Buys

Foreign sales/buys can be government-to-government, industry-to-government, or industry-to-industry. The planning strategy for weapon systems involves the identification of the requirements within possible markets. Systems that have been developed and produced in one country may become, for economic reasons (for example, reduced unit price), the subject of export considerations. If it is known during the development and production phase of a new system that the system may be exported, the existing environmental laws of the potential importer(s) must be considered when determining the requirements.

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As of 1996, the U.S. has cross-servicing agreements with the following countries and organisations: Australia, Bahrain, Belgium, Canada, Denmark, France, Germany, Israel, Italy, Jordan, Korea, Luxembourg, Malaysia, NATO Maintenance and Supply Agency (NAMSA), Netherlands, Norway, Spain, Thailand, Tunisia, and the United Kingdom.

◆ ◆ ◆

If the potential import countries have tougher environmental laws, consideration of these laws may increase the development cost of the system. However, this cost increase must be weighed against the gains of potentially lower operations and maintenance costs. If the potential import countries have less stringent environmental laws, it is important not to ignore the developing country's own environmental requirements. Each producing nation has a global environmental responsibility to ensure that all environmental requirements are at the right level, both with regard to national and international regulations.

Modern weapon systems consist of many

components with many subcontractors within the country and abroad. Environmental considerations should be integrated in the development and production processes, so that they are passed down to as many subcontractor tiers as possible.

Co-operative Logistics

International co-operation goes beyond research, system development, production and fielding to include other aspects such as logistics support and final disposition. The logistics of a system affect a greater percentage of a system's cost over a longer time frame than do other aspects of a program. Co-operative logistics include actions to meet common requirements associated with support and the development of plans and procedures. Logistics co-operation can be part of a development program, or it can be an independent program.

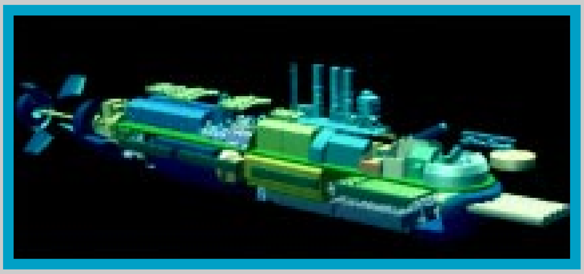
Many countries have the authority to obtain logistics support, supplies, and services from host nations while deployed outside of their respective countries. There are also cross-servicing agreements where logistics support, supplies, or services may be reciprocally provided between eligible countries.

The North Atlantic Treaty Organisation's Maintenance and Supply Agency (NAMSA) is the NATO organisation through which multilateral logistics co-operation among NATO member countries is accomplished. When participating countries sign a NAMSA Weapon System Partnership Agreement, the organisation provides depot and supply services for common weapon systems. In addition to NAMSA, other co-operative logistics agencies and efforts include the Central European Pipeline System, the NATO Infrastructure Program, Host Nation Support agreements, Lines of Communication agreements, Prepositioning agreements, and War Reserve Stock for Allies agreements. These examples of logistics co-operation illustrate the need for acquisition program managers to identify the environmental requirements of future/potential host nations, in order to ensure that the developing weapon system can be effectively maintained when deployed to foreign sites.

Swedish Co-operative Weapon Systems

VIKING

Because advanced weapon systems are complex and costly to develop, Sweden, Denmark, and Norway are jointly developing the VIKING submarine, which is currently in concept development. If the results of this development phase indicate that it is not possible to produce a single submarine to meet each nation's requirements, it is hoped that a modular design could produce a "family" of submarines suitable for all three nations.



HUGIN

An example of a project with major foreign subsystems is the 25-year-old Swedish patrol vessel type Hugin, which was based on the existing STORM-class gunboat. The Hugin was supplied with German main engines, French turbine equipment, a Swedish artillery system, a United Kingdom radar warning system, and was constructed in Norway.

Defence officials from Norway, Russia,and the United States shake hands on joint efforts of the Arctic Military Environmental Co-operation program.

International Environmental Co-operation and Agreements

Environmental co-operation is an important factor in many nations' "preventive defence" strategies. Defence departments have instituted and participated in environmental programs with global interest, such as the Arctic Military Environmental Co-operation; various environmental bilateral and trilateral co-operation agreements; international conferences; and specific environmental projects under NATO's Partnership for Peace initiative, the Science Committee, and the Committee on the Challenges of Modern Society. In addition to these specific military environmental initiatives, it is important to consider that there are numerous major global environmental treaties that may impact military activities. Some of the major treaties are summarised below.

- The Rio Conference, 1992 - The United Nations Conference on Environment and Development. Agreements from the conference include:
  - The Rio Declaration - A list of 27 principles vital to achieving sustainable development, and
  - Agenda 21 - A comprehensive work plan for national actions and international co-operation for sustainable development and global environmental issues.
- The Maritime Pollution Protocol (MARPOL), 1973/1978 - An international agreement to preserve the marine environment by reducing pollution from ships.
- The Montreal Protocol, 1987 - An international agreement tied to the Vienna Convention on the protection of the ozone layer.
- The Basel Convention, 1995 - An agreement that regulates the disposal and transboundary movements of hazardous waste.
- The Bonn Convention, 1982 - Addresses the conservation of terrestrial, marine and avian migratory species through their range.
- The United Nations Environment Programme (UNEP), 1993 - UNEP issued its decision, "Application of Environmental Norms of Military Establishments." This decision encourages governments to establish an environmental policy for the military sector.

Environmental Laws and the Military Sector

Environmental requirements affect the ability of military forces to train with other countries. As national environmental standards become increasingly stringent, the disparity between the host nation's environmental requirements and the environmental standards of the visiting force may increase. Visiting forces are generally required to meet foreign domestic environmental requirements as a matter of policy. The NATO Status of Forces Agreement (SOFA), for example, requires visiting forces to respect the law of the receiving State. Regardless of whether or not a requirement is mandated by law, any non-compliance is damaging to the relations between the host nation and the visiting force.

Considering the trend to be more specific regarding environmental requirements, it is imperative that militaries understand the consequences of non-compliance — cost, political controversy, and potential loss of access to the installation. With this in mind, program managers should endeavour to harmonise their programs to meet the environmental requirements established by their country's domestic standards, by military policy, by host-nation environmental standards, and by international agreements.

Environmental Considerations in Peacekeeping Operations

During the Bosnia peacekeeping initiative, the U.S. military adopted environmental requirements in their concept of operations.

- Consider environmental impacts and efforts to avoid or minimise adverse environmental impacts during all aspects of the operation.
- Balance efforts against the requirements of force protection and military necessity.
- Apply best practical and feasible environmental engineering and sanitary practices.
- Act to ensure safe disposal of U.S. wastes.

Some of the major environmental issues encountered include:

- Problems transferring hazardous waste through Croatia.
- Inconsistent environmental standards among participating nations.
- Environmental awareness/knowledge required at all levels (service components, commanders, soldiers, etc.).
- Eventual remediation requirements for fuel contaminated sites and United Nations hazardous waste sites.

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EXAMPLE: The F-16 Co-operative Program

This is a hypothetical example that illustrates how environmental considerations could have been integrated into the multi-national F-16 program, a system that was mostly produced before the establishment of requirements and processes to integrate environmental requirements into the acquisition process. This aircraft is a high-performance fighter selected to replace the F-104 Starfighter in 1975 by the U.S. Air Force and four European countries: Belgium, Denmark, Norway, and the Netherlands (which came to be known as the European Consortium). The F-16 weapon system is a useful example due the fact that throughout its life cycle it has encompassed many different aspects of international co-operation: development, production, operation, maintenance, and disposal.

Introduction

Generally, various factors affect a country's decision-making process when participating in co-operative defence acquisitions. Some of the factors include: defence export financing, price, cost and availability of follow-on support, system performance, lead time for delivery, availability of training, and offsets. Environmental issues can play a role in many of these factors. For example, minimising the requirement for hazardous materials throughout the life cycle of the weapon system can significantly reduce follow-on support costs without adversely affecting the system's initial purchase price. Failure to address hazardous material early can cause customer rejection of an article based on its material content, unexpected reverse-engineering requirements, and resulting system delivery delays. The need for training (hazardous material use, handling, storage, and disposal) also increases with the use or generation of hazardous materials.

Offsets are obligations by the seller to provide the purchaser a method to minimise trade imbalances caused by the purchase of a system. The offsets can be direct, such as production or assembly, or indirect, such as technology transfer and/or the purchase of raw materials, equipment, or supplies from the buying country's indigenous businesses. A major factor in the Consortium's involvement with the F-16 project was the inclusion of offsets. In the Memorandum of Understanding there were requirements for co-development, co-production and assembly. Examples of other methods of using offsets to address the environment from

F-16 Flying over Monument Valley, Arizona

Boeing-St. Louis programs include: using environmental technology; providing training to the purchasing country on corrosion-control technology and the environmental impacts of each technique; forming a company within the purchasing country to manufacture a product that cleans up oil spills; creating another company that recycles used photocopier and laser computer cartridges within the purchasing country; and paying for a U.S. law firm to draft a country's environmental laws.

MOU Development

Because the F-16 program Memorandum of Understanding (MOU) between the U.S. and the Consortium included the participation of the Consortium in the development of the program, as well as in the production, each of the four Consortium countries had the opportunity to influence the development of the system with regard to unique domestic environmental requirements. The MOU also addressed the affordability and supportability aspects of the F-16, which can be affected by environmental non-compliance. Minimising the use of hazardous materials and planning for environmental compliance for the life cycle of the aircraft within each country could have also been required under the auspices of affordability and supportability improvements.

From the environmental compliance perspective, all joint programs must be addressed on a case-by-case basis. Early during the design phase of a program, environmental requirements of each nation should be identified and evaluated as to their impacts and relevancy to the acquisition program at hand. This evaluation should be documented in the internal environmental strategy of the acquisition program.

During the negotiations between participating countries in the development of the MOU, possible environmental issues to address include:

1. Identifying whether a common environmental strategy will satisfy the environmental needs of all participating nations;
2. Establishing the boundaries of the system's life cycle, such as the likely locations where manufacturing, testing, final assembly, maintenance and disposal will occur;
3. Determining whether country-specific environmental considerations will be required of the weapon system prime contractor; and
4. Determining the extent of foreign country participation in the integration of environmental considerations into the weapon system development or production processes.

Contractual Requirements

The U.S. Air Force managed the basic contractual requirements for the F-16 aircraft, with representatives from each of the four Consortium countries participating in the program office. The Statement of Work (SOW) is the primary contractual requirement that tasks the contractor and usually consists of a scope, a list of specifications and standards, and the required tasks to be performed. Although the current emphasis is to write performance-based specifications, this was not the case at the time of the F-16 program. Numerous materials and process specifications would have been the norm for a contract at this time. Many specifications and standards required the use of particular materials and processes. The Consortium countries could have initiated a review of the specifications to ensure that none of the requirements had the potential to violate their domestic environmental laws, or the U.S. Government could have initiated the same review with support from each country. Another alternative could have been to require the U.S. prime contractor to perform this review with the assistance of the Consortium subcontractors.

As of 1998, there is no standard method of addressing the environmental regulations of individual countries within co-operative programs. Issues are usually addressed on a case-by-case basis. For example, Boeing-St. Louis stated that "if a foreign subcontractor cannot build our article to print using materials we have specified, we will grant that company a deviation and help them substitute an appropriate material. Similarly, if a customer rejects an article due to its material content, we will substitute with suitable materials. Unfortunately, this involves reverse engineering and is very costly." To help minimise these costs, Boeing-St. Louis initiated a new effort to assign a Materials and Process Engineer to programs to identify environmental liabilities on a program-specific basis. In addition to these production initiatives, the government should take responsibility for ensuring the prime contractor addresses the environmental aspects of operating, maintaining, and disposing of the weapon system, regardless of where it will be deployed.

Chapter 4: Environmental Requirements and Actions

Most countries have specific directives regarding the acquisition of weapon systems. These directives are likely to include reference information not only on developing new weapon systems, but also on acquiring commercial and non-developmental items (NDIs). The use of existing, previously developed items - whether commercial or military - saves research and development costs, shortens fielding time, and reduces the risk associated with new development. Figure 4-1 graphically shows the range of acquisition options as they relate to development time and cost.

Various approaches are used to conduct environmental analyses within a program based on the type of acquisition, the phase of the program, and the overall program management philosophy. Because weapon system acquisition approaches can fall anywhere along the curve (shown in Fig. 4.1), it is difficult to provide a list of detailed environmental actions required for all possible acquisition scenarios. As such, this chapter will focus on three approaches:

- acquisition of commercial and NDI (buy-off-the-shelf) systems;
- militarisation, ruggedisation, or modification of commercial and NDI systems; and
- total development of new weapon systems.

This chapter is intended to provide an overview of the environmental requirements and actions that should be considered in these three acquisition approaches. Additionally, this chapter includes cross references to the tools in Chapter 5 that may be useful for completing each of the actions described in the following checklists. When a program manager chooses an acquisition approach other than one of the scenarios described here, it may be necessary to combine the actions from one or more of the checklists in this chapter.

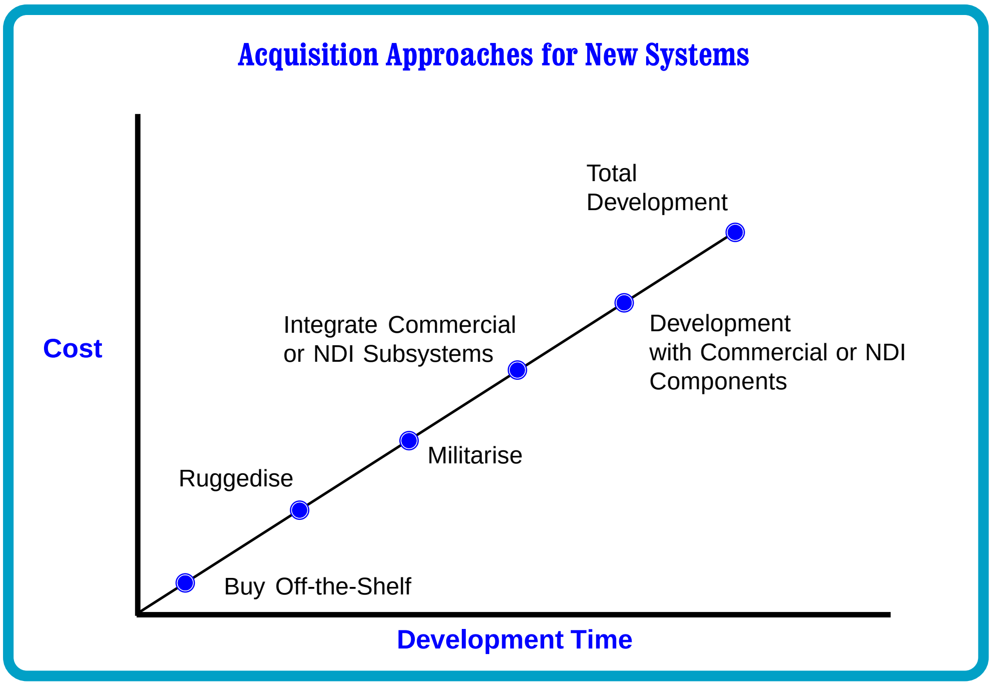


Figure 4.1: Acquisition Approaches Chart

Commercial and Non-Developmental Items

A commercial item is any item used for non-governmental purposes and offered for sale to the public. A non-developmental item (NDI) is defined as any item previously developed for governmental purposes, including those developed by another nation.

Opportunities for using commercial and NDIs include not only purchasing an off-the-shelf item as a stand-alone system, but also for incorporation into new weapon systems. Both of these approaches have demonstrated significant savings in research and development costs. Opportunities to use commercial items, especially at the subsystem and component levels, should be pursued and addressed at each phase of development. In addition to saving cost and time, buying from the commercial market provides militaries with access to state-of-the-art technology and products. In many of the technological areas significant for defence items, industry leads the government in research, development, and application. For example, in the fields of communications, electronics, and computers, the rate of technological development resulting from high commercial demand surpasses the capabilities of government research and development (R&D) programs.

Environmental Considerations in Commercial & Non-Developmental Items

Acquisition and use of commercial and NDIs may involve significant environmental issues that must be addressed before a system is selected for purchase. Preferably, environmental issues should be addressed when developing the acquisition strategy. These issues are usually associated with testing, training, using, maintaining, and disposing of the system.

The process for considering environmental hazards for commercial and NDIs is different from the process used for developmental systems. Unlike a developmental item, there is little chance to influence environmental characteristics and impacts of commercial and NDIs. This places a greater burden on the program manager to identify potential environmental hazards associated with the intended military application of the item early in the program. Once a contract to purchase the system is completed, the manufacturer has little or no incentive to address environmental issues, unless these issues are specifically defined in the contract.

Market investigation is an important tool for gathering information on commercial items and NDIs that may be offered as part of the system, or as the system itself. This investigation should be done before the users draft the document that describes the product and services to be purchased. To ensure environmental considerations are included, environmental professionals should be part of the market investigation team.

The technical requirements for the commercial and NDIs should be written using the insight gained from the market investigation process. Although the manufacturer of the weapon system or system component is responsible for environmental stewardship under the laws and policies of the government, the weapon system manager should be aware of the associated impacts, including costs, of using the item. To accomplish this, environmental requirements and instructions should be inserted into the solicitation at appropriate locations. Program managers may find the use of eco-labels or requirements found in eco-labelling systems useful for developing some environmental requirements for a solicitation. If environmental impacts will be considered in evaluating offers, the manufacturers must be informed in the solicitation.

If the environmental impacts associated with testing, using, maintaining, or disposing of the commercial and NDIs are significant enough to keep the system from meeting the technical requirements, then program managers should investigate the options. Often, minor modifications are customarily available in the commercial marketplace. "Minor" modifications are those that do not significantly alter the function or essential physical characteristics of the item or component. If minor modifications will not mitigate the environ-

Environmental Considerations In Buying A Commercial Helicopter: What Should Have Been Done?

When the Swedish Air Force needed a new search and rescue helicopter, the decision was made to buy a commercial "Super Puma" helicopter from the French company Aerospatiale.

As part of the contract, maintenance products were also procured. Unfortunately, no environmental requirements were placed on the maintenance products. As a result some 50 maintenance materials were received without chemical composition data sheets or with product descriptions written in French only. This made it nearly impossible to write specific maintenance procedures to ensure safe and environmentally responsible use of the products.

To correct this problem and to ensure that all products met Swedish environmental regulations, the Swedish Air Force requested that additional information be provided by Aerospatiale. Unfortunately, since this was not part of the original contract solicitation, extensive time and resources had to be expended to collect the additional information and/or modify maintenance materials/procedures. However, if the environmental requirements for the maintenance materials had been clearly delineated in the original contract solicitation, it is expected that several million Swedish kronor could have been saved.

mental impacts to an acceptable level, then the potential item may not be satisfactory. If all of the potential commercial and NDIs have significant impacts, then consideration should be given to purchasing a militarised item or developing a new one.

Specific environmental considerations vary with the type of item being purchased. For example, the acquisition of an existing weapon system such as an aircraft or armoured vehicle from a foreign military (a NDI) could require significant environmental analyses, including the use of Environmental Impact Assessments (EIAs), Hazardous Material Management Programs, and other analysis tools. However, in general, commercial and NDIs require a much less detailed environmental analysis than is needed for developmental items. Nonetheless, the analysis tools described in Chapter 5 can still be used. For example, while a Life Cycle Assessment (LCA) may be more appropriate for use in reviewing options for a developmental system, a program manager could use life cycle thinking or a simplified LCA to evaluate different commercial or NDI systems under consideration.

The next page contains a checklist that may be used by program managers during the acquisition of commercial or NDIs.

Commercial/NDI Checklist

✓	Actions
	1. Conduct a market investigation to gather information on commercial and NDIs. Include environmental factors in the investigation. This should be accomplished by using environmental professionals as members of the market investigation team. Technical data sheets, material safety data sheets, and other product literature may be helpful in determining environmental attributes.
	2. Identify third party certification programs such as eco-labelling programs that may evaluate environmental aspects of the item.
	3. Begin a review and evaluation of market investigation results. Ensure that information has been collected on all environmental aspects including: • Environmental impacts (air pollution, noise, etc.) of system testing, operation, maintenance, and disposal. • Protective equipment required during operation, maintenance, storage, transport, or disposal of the system. • Ecosystem impacts (endangered species, wetlands loss, fragile ecosystems, erosion). • Energy, water, and non-renewable resource consumption. • Chemicals and processes required for using, maintaining, and repairing the system or contained within the system and the resulting potential impact. • Environmental laws and regulations unique to the item being investigated - Special licenses, certificates, waivers, or permits required to own, store, use, or dispose of the system. - Special permits or modifications to existing permits required by the potential supplier to produce the quantity of items needed. • Technical documentation and training materials to account for hazards presented by the item.
	4. Develop the environmental technical requirements for the contract solicitation using the insight gained from the market investigation process. Inform contractors of the environmental impacts that will be closely considered in evaluating offers.
	5. After receiving offers for the solicitation, evaluate environmental impacts, costs, and other factors specified in the solicitation. If most or all products reveal significant environmental impacts, consider use of “minor” item modifications to reduce these impacts.

Militarised Items

If commercial or NDI systems will not meet requirements, either due to unacceptable environmental impacts or other reasons, then a program manager should give consideration to purchasing a militarised item. A militarised item is a commercial or NDI that requires “major” modifications (modifications that are not normally customary in the commercial sector or go beyond minor modifications) to meet the military’s performance requirements. In many countries, the militarised item acquisition approach is now much more common and has nearly replaced the full developmental approach due to decreasing military budgets.

Environmental Considerations in Militarised Items

Like commercial and NDIs, there is less chance to influence environmental characteristics of militarised items when compared to developmental systems. However, if the environmental attributes and impacts are significant in a militarised item acquisition, in-depth environmental analyses and modifications may be necessary.

The decision to use a militarised item acquisition approach is made after determining that existing off-the-shelf or slightly modified items will not meet the military’s requirements. Like commercial and NDI system acquisitions, a market investigation is again an important tool for gathering information on environmental attributes of proposed items. Environmental professionals should once again be part of the market investigation team. One of the primary outputs of the market investigation will be a determination of whether environmental impacts of the item will be significant enough to be addressed as modifications to the item. Even though a militarised acquisition approach may be chosen to correct other deficiencies in the item, the primary driver of the acquisition is usually cost and schedule. Therefore, environmental modifications to the item should only be made when deemed essential.   Any proposed modifications and basic technical requirements for the militarised item should be based upon the insight gained from the

market investigation process.

Specific environmental considerations may vary greatly depending on the size of the militarised acquisition program and type of item being purchased. Therefore, it is difficult to provide a detailed method for environmental analyses that will be applicable to all militarised acquisitions. For example, while it is unlikely that a full environmental impact assessment (EIA) would be required for a small system such as a militarised portable Global Positioning System (GPS) receiver, it is very likely that an EIA would be necessary for the acquisition of a militarised jet training aircraft. The generic checklist contained on the next page could be used as a basis for a “tailored” checklist that would be prepared by program management personnel. To ensure that all necessary environmental impacts are considered, program managers should also review the commercial/NDI program and developmental program sections and action checklists in this chapter to determine if one or more of these sections and checklists better fits their acquisition programs.

Militarised Aircraft for the Joint Primary Aircraft Training System

The Joint Primary Aircraft Training System (JPATS) is a joint U.S. Air Force and Navy program to replace the USAF's T-37B training aircraft and the Navy's T-34C training aircraft and their associated ground-based training systems (GBTS). The JPATS includes the aircraft, GBTS, and contractor logistics support.

The principle mission of the JPATS is to train entry-level student pilots in primary flying to a level of proficiency where they can transition into one of the advanced pilot training tracks leading to qualification as military pilots. The program also supports the training of U.S. Air Force and Navy Instructor Pilots.

The JPATS acquisition strategy was to acquire an existing aircraft and training/support system requiring limited modifications (militarisation) to satisfy JPATS operational requirements. The potential contractor competition was open to U.S., foreign, or U.S./foreign aircraft manufacturing teams. The solicitation contained all U.S. Air Force and Navy requirements for the aircraft and aircraft support.

The program office awarded both contracts based on best value to a single aircraft contractor. The source selection criteria clearly favoured proposals involving the lowest development risk and the lowest total system cost to the government. A single, integrated test program was developed to accommodate verification of contractor, FAA, and military requirements without duplication of effort or costs.

On 22 June 1995, Beech Aircraft Company won the competition and was awarded the JPATS contract. The Beech Mk II aircraft is derived from an existing commercial aircraft. The militarisation process involved the application of existing, stable technologies to the basic Beech Mk II to create the final JPATS configured aircraft. Militarisation of the basic aircraft consisted primarily of anthropometric changes to the cockpit to increase the accommodation of smaller aviators, new avionics displays and improved bird-strike protection.

The minimal development involved with the program provided an opportunity to place additional requirements on the contractor in specific operation and support areas, including environmental and safety issues. Safety and hazard analyses were required, and noise limits were placed on the aircraft. Pollution prevention initiatives were outlined for a proactive approach at minimising future mitigation requirements and life cycle cost reduction. The JPATS Program also prohibited the use of all Class I Ozone-depleting Substances (ODSs) and targeted the use of Class II ODSs. Additionally, the JPATS contract included lists of banned and targeted hazardous materials for production, operation and maintenance of the system. The lists include chemicals identified as causing specific concern to the Air Force, including CFCs, asbestos, PCBs, lead, cadmium, and many others. Heavy management emphasis was placed on the elimination/reduction of chemicals on these lists, requiring the contractor to justify his use of any targeted chemical based on life cycle trade-off analyses.

Militarised Item Checklist

✓	Actions
	1. Conduct a market investigation to gather information on commercial and NDIs. Include environmental factors in the investigation. This should be accomplished by using environmental professionals as members of the market investigation team. Technical data sheets, material safety data sheets, and other product literature may be helpful in determining environmental attributes.
	2. Identify third party certification programs such as eco-labelling programs that may evaluate environmental aspects of the item.
	3. Begin a review and evaluation of market investigation results. Ensure that information has been collected on all environmental aspects including: • Environmental impacts (air pollution, noise, etc.) of system testing, operation, maintenance, and disposal. • Protective equipment required during operation, maintenance, storage, transport, or disposal of the system. • Ecosystem impacts (endangered species, wetlands loss, fragile ecosystems, erosion). • Energy, water, and non-renewable resource consumption • Chemicals and processes required for using, maintaining, and repairing the system or contained within the system and the resulting potential impact. • Environmental laws and regulations unique to the item being investigated - Special licenses, certificates, waivers, or permits required to own, store, use, or dispose of the system. - Special permits or modifications to existing permits required by the potential supplier to produce the quantity of items needed. • Technical documentation and training materials to account for hazards presented by the item.
	4. If needed, conduct a simplified life cycle assessment and life cycle cost analysis to determine necessary modifications to the item.
	5. Develop the environmental technical requirements for the contract solicitation using the insight gained from the market investigation process. Inform contractors of the environmental impacts that will be closely considered in evaluating offers.
	6. Concentrate on logistic support procedures for the system. Ensure that hazardous material substitutions are incorporated into the maintenance processes.
	7. Ensure that an environmental impact assessment is completed prior to making decisions on system testing.
	8. Incorporate environmental requirements into follow-on production contract language.
	9. Ensure that the environmental impact assessment is completed prior to making decisions on system production and deployment.

Developmental Programs

When commercial, NDIs, and militarised systems will not meet the military's requirements, development of a new weapon system will be necessary. As part of the development process, environmental efforts should be established for both the Government's and contractor's systems engineering process and managed in a unified, disciplined, and iterative manner. Program managers need to recognise that the Government and contractors have their own environmental interests, and the environmental responsibilities for each phase of the system development must be clearly assigned.

Various approaches are used to include environmental analyses within a developmental program. In addition, there are different methods of reporting results, progress, and decisions reached as a result of the environmental analyses. Although development processes vary from country to country and program to program, a typical development process includes the following phases:

- Concept Development
- Preliminary Design/Prototype
- Detail Design/Pre-Production Model
- Production and Deployment
- Operation and Maintenance
- Demilitarisation, Reuse, and Disposal

The following pages provide a listing of representative environmental issues that should be considered and addressed during each phase of a typical system development process.

Concept Development

In the concept development phase there are typically several short-term studies that are evaluated based on feasibility, degree of risk, and estimates of general cost, schedule and performance. The intended operational use of the system, including the operational environment, may place constraints on possible design, operation, support, and disposal scenarios. Environmental constraints that may be important include access to land, sea, and airspace for testing, training, and basing; legal standards and statutes affecting strategic material resources; adverse environmental impacts; and safety and health impacts on operational and maintenance crew members. These constraints should be identified in the documents describing the needs for a new system. Information may be available from analysis of existing systems that satisfy similar needs.

By definition, the concept of the weapon system will not yet be fully developed. Therefore, it is unlikely that detailed environmental analysis can be performed during this phase of the acquisition process. Instead, the program manager should focus on developing and implementing an environmental management system (EMS), which includes: the program's environmental organisation structure, a training program for acquisition personnel, and an environmental policy. In addition, during the concept development phase, preliminary information should be collected to be used for different types of environmental analyses that will be used in subsequent acquisition phases. A Strategic Environmental Assessment (SEA) could be used to compare environmental impacts of alternative concepts.

Although a thorough life cycle and risk analysis is not possible in the concept development phase, preliminary evaluations may be possible using the basic principals of these tools. For example, the decision to develop a wheeled versus a tracked vehicle must be made very early in an acquisition program. If both are viable from an operational requirement standpoint, the differing environmental impacts of the two may be an important decision-making factor. Another example of a system characteristic with significant environments impacts that must be determined very early is the selection of a ship hull form. If one hull form has a greater draft than similar ships, its use may require the dredging of port facilities. Early environmental analysis becomes extremely important in this scenario.

The next several pages contain a checklist that may be used by program managers during the concept development phase of an acquisition program.

The Surface Combatant of the 21st Century: Integrating Environmental Requirements During Concept Development

The U.S. Navy Program Office for the Surface Combatant of the 21st Century (SC-21) addressed environmental requirements in the initial concept development stage of the acquisition process with the stated purpose to reduce life cycle costs of the ship. For example, operational environmental impacts and requirements of approximately 50 potential SC-21 systems were identified early in the engineering development cycle by baselining with an existing similar ship (DDG-51) and including environmental impacts of proposed new technologies that might be included in the SC-21 design.

In the case of operational environmental impacts and compliance, environmental requirements were developed that included a minimum threshold based upon current requirements as modified by near-term (10-15 years) changes in requirements that are likely and known. As part of this process, the SC-21 Program Office attempted to standardise environmental requirements across national and international boundaries. In addition to the thresholds, environmental goals were set based upon anticipated long-term environmental requirements (40+ years) that, if met during the initial acquisition, should allow the ship to operate in an environmentally sound manner with no restrictions throughout its life cycle. Although the goals might not have been achievable during initial acquisition and production, they served an interim purpose as performance targets for research and development efforts. (Note: Although thresholds and goals were not included in the actual contract solicitations, these documents were made available to parties bidding on the contract.)

The SC-21 "family of ships" will begin to replace retiring frigates, destroyers and cruisers by the turn of the next decade.

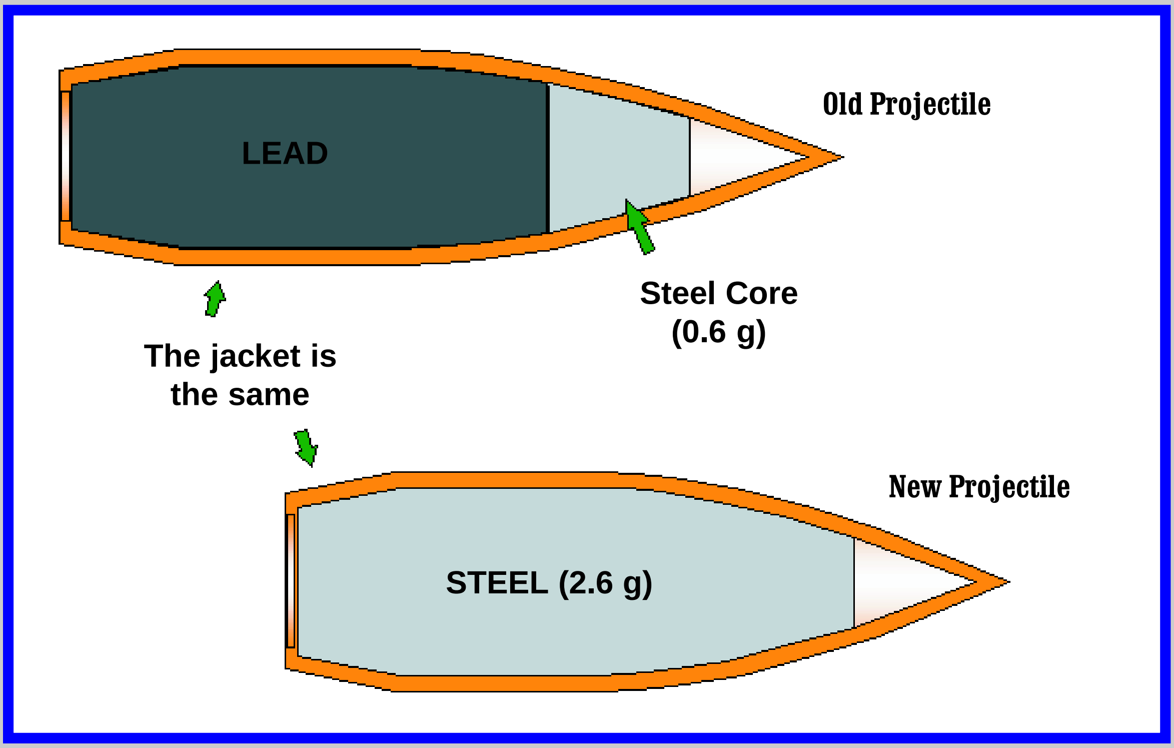
Environmentally Adapted Small Calibre Ammunition

In order to reduce the environmental impacts of small calibre ammunition, Sweden determined that a new type of cartridge would be needed. From the start of the concept development phase, the environmental impacts of each component were considered, which resulted in a more environmentally friendly 5.56 mm cartridge as well as improved packaging.

Environmental impacts of the existing ammunition were determined to result from lead and lead-compounds contained in the existing cartridge and non-recyclable cartridge packaging. To alleviate these impacts, the original lead-and-steel core was replaced with a homogenous steel core. The primer composition that contained lead oxide was replaced by a sintoxide type. The old lead-and-steel projectile had a steel core that could strike through a 3.4 mm sheet of steel from a distance of 570 m, but only the part containing the 0.6 g of steel would go through. The new projectile can strike through the same sheet of steel from a distance of 400 m, but the whole projectile of 2.6 g of steel goes through. Considering that the fighting distances of modern infantry battle seldom exceed 300 m, the Swedish Armed Forces decided that the performance of the environmentally adjusted cartridge was better than the old one. The soldier does not notice any difference between firing the old and the new cartridge and the environmentally adapted cartridge costs the same as the old one.

The packing materials for the cartridges was also improved. The cartridges used to be packed first in small paper boxes which were then put in a polyvinyl chloride (PVC) bag as vapour barrier. These PVC bags were then put in a wooden transport box. All the boxes and PVC bags were usually burned out in the open during shooting exercises. The environmentally adapted cartridges are still put in paper boxes, but these are now put in a steel box with an advanced vapour barrier. The steel box is recycled and filled with new cartridges after the old ones have been used.

The result of this new cartridge and packaging concept is that the lead emissions have been reduced by 2200 kg of lead and 250 kg of PVC when shooting one million cartridges.



Concept Development Checklist

✓	Actions
	1. Determine the program mission's environmental needs: • Analyse environmental cost and operational readiness drivers of currently fielded systems and identify cost targets for improvement. • Develop alternative fielding plans and operating concepts, and evaluate their potential environmental implications on resources. • Assess environmental program requirements, resource impact, and risk-reduction measures for alternative acquisition strategy options, fielding strategies, etc. • Identify new technologies that are or will be available for insertion into the proposed concept(s).
	2. Define baseline operational scenario(s) for the most promising system concept(s). The scenario must include peacetime and wartime operations and have adequate detail for environmental planning purposes. As appropriate, environmental requirements should be incorporated into documents describing operational requirements and/or technical requirements. Preliminary environmental objectives and thresholds should be established. • Identify regulations (national and international) that may apply to the operational system or to system support. • Assess potential environmental impacts over the system life cycle. This is critical for munitions, missiles, and other systems with energetic or toxic materials, and for systems with the potential for environmental impacts during training, operations, and disposal.
	3. Establish the program's environmental policy and distribute to program staff.
	4. Prepare a programmatic environmental evaluation. Projected resource requirements should be identified and included in program funding proposals. Objectives, goals, and thresholds should be identified. Any required support from other government activities should be identified and a memorandum of understanding that defines roles and responsibilities should be developed if appropriate.
	5. Provide environmental training and awareness to program personnel.
	6. Obtain environmental expertise for the remainder of the program's developmental phases.
	7. Select program organisational structure and build environmental analysis scenarios into the program team structure.
	8. Include appropriate environmental requirements (developed in basic weapon system documentation) such as operational requirement documents; research, development, testing, and evaluation plans; logistics support plans; facilities planning documents; disposal plans; etc.
	9. Integrate environmental requirements and considerations into solicitations and contracts for subsequent acquisition phases.
	10. Identify technologies that could reduce life cycle costs and environmental impacts. Where environmental costs and/or risks are considered moderate to high and existing mitigating technologies are unavailable, consider investing in research and development of new technologies.

Preliminary Design / Prototype

During this phase, the program typically defines one or more concepts or design approaches. If there is more than one concept, the advantages and disadvantages of the alternative concepts are refined, and operational assessments and demonstrations are conducted. An important aspect of this phase is usually to reduce risk so that the technology, manufacturing, and support concepts are mature enough to meet the program's cost, schedule and performance needs.

At this stage of the program, there is enough information available about the intended weapon system that an environmental strategy can be developed for the system's life cycle. This strategy should include: an environmental compliance assessment; a pollution prevention program; a hazardous-materials identification, control and management program; and a program budget. To ensure that the program develops a successful environmental strategy, the program manager and an environmental specialist must integrate many disciplinary areas from functional support organisations to provide advice and expertise in specialised areas. The specialised areas may include materials, engineering, legal, or military field expertise as examples.

Because environmental regulations are continually changing, an environmental compliance assessment should be a continuous process throughout the development of the weapon system. Weapon system prime contractors are responsible for their own environmental compliance, but the program manager should ensure that the contractor will not be in jeopardy of non-compliance. The program manager should then focus on the environmental compliance requirements to operate, maintain, and dispose the weapon system and its components. The assessment should include identifying compliance

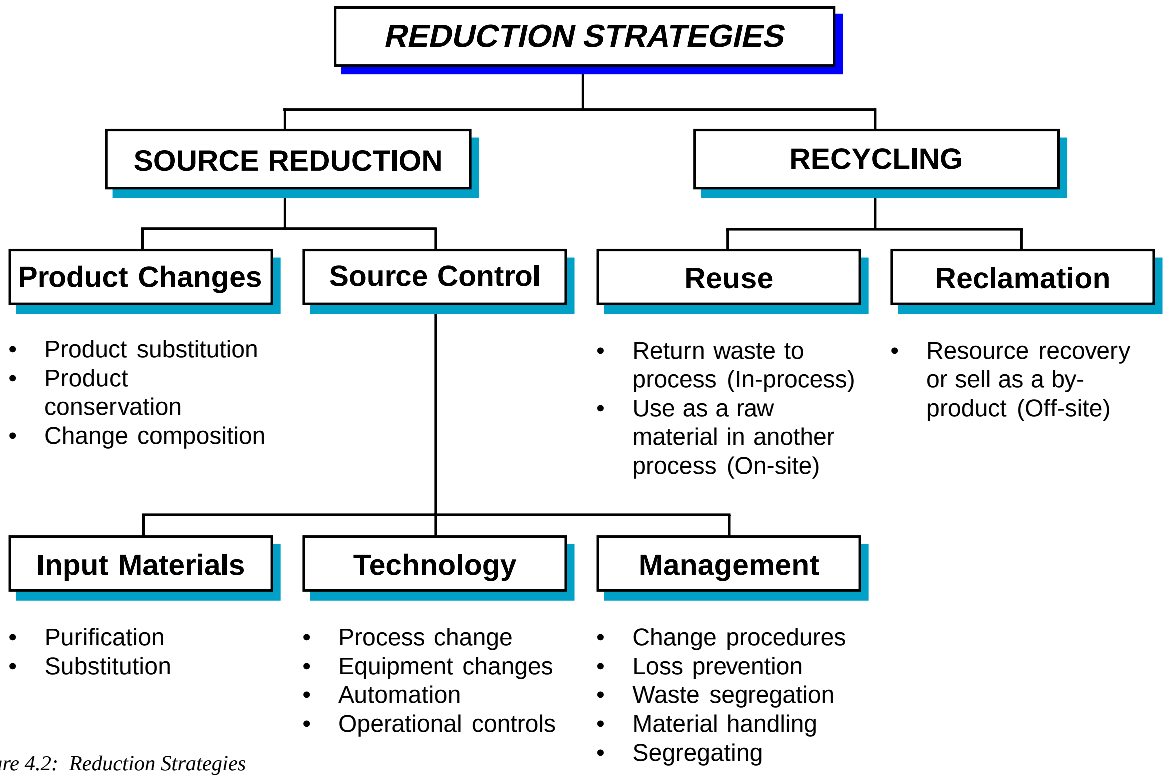


Figure 4.2: Reduction Strategies

cost-drivers at the sites where the system will be constructed, operated, maintained, and ultimately disposed of. These requirements should be based on documented regulations, scheduled revisions to regulations, and speculation on future regulations. This review should include international agreements, treaties, and host nation obligations for environmental requirements. Based on the compliance assessment, initiatives should be established to outline general courses of action that will meet the requirements. The course of action could include pollution prevention initiatives or possible weapon system design changes.

The preliminary design phase provides an excellent opportunity to integrate pollution prevention initiatives into the weapon system program. A pollution prevention program should be established to minimise environmental impacts and the life cycle costs associated with environmental compliance. Pollution prevention analyses include: identifying the impacts of the system on the environment; wastes released to the environment; environmental risks associated with technologies, products, equipment, and processes; procedures that prevent losses, spills, and waste; and other studies needed to identify source reduction and recycling opportunities. Figure 4-2 identifies strategies that may be used for achieving pollution prevention. It is important to realise that these pollution prevention strategies can be used in other stages of the weapon system development process, and that different strategies are more appropriately used at different times. For example, the management procedures would not be productive during Preliminary Design / Prototype phase.

It is also important in this preliminary design/prototype phase to establish a hazardous materials program. The material selections in this phase may or may not be representative of the materials that will be selected for use in the detail design phase, but they will probably be similar. At a minimum, it is essential that a process for evaluating the selection of hazardous materials be established.

Many prime weapon system contractors

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Because major design changes are not likely to occur after the preliminary design/prototype phase, it is important to identify significant design decisions that may impact the environment or incur significant costs over the life cycle of the weapon system in this phase. By following a program-specific pollution prevention strategy, the design of the weapon system can be influenced to minimise both the impact on the environment and the life cycle cost.

Some simple examples in which pollution prevention was successfully implemented, and some examples in which it was unsuccessfully implemented are the following:

Good:
- ✔ Plastic waste recycling units were installed aboard U.S. Naval ships.
- ✔ Non-ozone-depleting fire-suppression systems were designed into new production aircraft.
- ✔ Munitions were designed with recyclable energetic compounds.

Bad:
- ✘ The prime contractor of a high-performance radome program selected a material that required methylene chloride in the fabrication process. Just prior to completion of material qualification testing, the manufacturer of the radome material notified the prime contractor that they were no longer going to make the material because it was being phased out of their product line as part of their hazardous material reduction effort. The impact of this change imposed a major risk to the program and raised program costs by $5 million USD from the baseline $35 million USD.
- ✘ Intermediate range ground-to-ground missiles were designed containing numerous components with hazardous materials. When the missiles were destroyed as a result of the Intermediate-Range Nuclear Forces (INF) Treaty, disposal costs of the various hazardous materials used in the missile increased the cost of the program by over $100 million USD or about 8% of the total program costs!

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New Attack Submarine: Integrating Pollution Prevention & Hazardous Material Control In Preliminary Design

The U.S. Navy Program Office for the New Attack Submarine established pollution prevention and hazardous material (HM) control programs early in the preliminary design process. Examples of how the programs were integrated into the design process include:

- The New Attack Submarine Environmental Management Team led an effort to develop a list of hazardous materials considered top priority for avoiding or minimising on the submarine. An initial list of hazardous substances, compiled from various sources, was assigned numerical "points" for several factors, including toxic/medical effects, physical characteristics, chemical characteristics, worker exposure limitations, and regulatory impacts. The points were totaled for each candidate substance. The final New Attack Submarine Hazardous Materials Avoidance List includes the ranking and total points for 70 hazardous substances. The list enables designers to focus their efforts on identifying alternative materials and processes as substitutes for the hazardous substances on the list.
- Reduced the number of paint products and solvents used in manufacturing and maintenance by 30% and 75%, respectively.
- Eliminated polychlorinated biphenyls (PCBs).
- Where some HM such as lead and chromated water were still required for use, recycled these HM from inactivated submarines.
- Included a HM map to identify the location and type of HM that could not be eliminated from the design.
- Developed recycling procedures to ensure that the submarine can be efficiently recycled and disposed of at the end of its 30+ year life.

have established their own internal hazardous materials programs. Often the process is very thorough for materials that they utilise within their manufacturing plants, but lacks in the analysis of materials used or generated during the operation or support of the weapon system. It is important to establish a hazardous materials program that is mutually agreeable to both the contractor and the program manager.

At this phase of the acquisition process, baseline operations, basing, and maintenance plans are being developed. Another effort that may take place is the testing of systems or components under evaluation. If there is the potential to impact the environment – air, land, sea, or endangered/threatened species or fauna – an environmental impact assessment should be completed that evaluates the proposed operations and testing. The associated environmental impact should be known prior to making any decisions.

Based on the environmental compliance assessment and the issues that have arisen as a result, specific environmental requirements should be developed to incorporate into the detail design contract language. In addition, the funding requirements for the next phase must be budgeted.

Preliminary Design/Prototype Checklist

✓	Actions
	1. Develop an overall program environmental strategy based upon refinement of concepts.
	2. Institute a hazardous material control and management program and evaluate the contractor's performance in carrying it out.
	3. Establish a pollution prevention program and evaluate the contractor's performance in carrying it out.
	4. Develop a program environmental budget.
	5. Begin an environmental impact assessment to support testing of the weapon system.
	6. Perform an environmental compliance assessment by reviewing national laws, international agreements, and treaties that must be met when the system is deployed in all countries. Establish environmental criteria that must be met to support the operations and maintenance of the deployed system.
	7. Establish a baseline support, operations, and maintenance concept. Conduct an environmental impact assessment.
	8. Develop a preliminary disposal plan. Ensure the system design allows hazardous materials to be accessed, removed, and safely disposed of or recycled. Influence system design to maximise the amount of material that can be recycled.
	9. Develop and incorporate environmental requirements into the detail design contract language based upon the environmental compliance assessment and the issues that have arisen as a result.

Surface Combatants: Preliminary Design Uncovers Environmental Bonus

The VISBY Class Corvette is the first in a series of new Swedish surface combatants. It is a flexible surface combatant with exceptional performance at both low and high speeds. The vessel is capable of Mine Counter Measure (MCM), Anti Submarine Warfare (ASW), mine laying, attack, reconnaissance, and patrolling, etc.

Some of the unique elements of the vessel are a small radar cross section by using advanced stealth technique, very low noise signature, reduced magnetic signature and high shock resistance. A very low hull weight at a reasonable cost was decisive for the ship's total performance and power. To achieve this goal and at the same time obtain good stealth qualities, the hull is built in a sandwich construction consisting of a PVC core with carbon fibre and vinyl laminate. In addition to improving operational performance, the combination of material choice and construction technology also resulted in a propulsion system that required only half the power of a conventional hull. The resulting energy savings in turn resulted in decreased air emissions, including greenhouse gases.

Detail Design/Pre-production Model

During detail design, the objectives are to develop a stable, producible, supportable and cost-effective design; to validate the manufacturing or production processes; and to demonstrate system capabilities through testing. The contractor is no longer making trade-offs on the concept design of the weapon system, but rather is making trade-offs in subsystem, structure or component designs.

During this stage of the weapon system development, it is critical for the program to have a stable program schedule and budget. Delays in the schedule may cause significant cost increases that can lead to cancellation of the program. While there is less opportunity to initiate new pollution prevention projects, the pollution prevention strategy initiated in the previous phase should be mature enough to integrate the results into the rapidly developing design. In addition to pollution prevention initiatives, environmental analyses must be incorporated into the contractor's decision management documents, life cycle assessment, life cycle cost analyses, and risk management analyses. The environmental analysis and hazardous materials management program must be integrated into the engineering process, because it is not cost-effective to review design and logistics decisions after the fact, and then try to make changes.

The environmental compliance assessment performed in the previous phase should be revised to ensure that any new environmental constraints for the program are identified. Based on new compliance requirements, the pollution prevention strategy may need to be modified. This strategy may also be modified due to the identification of new technologies that may provide significant payback over the life cycle of the weapon system. The program manager should evaluate new initiatives and modify the funding requirements where appropriate.

As specific hazardous materials are identified for use in the manufacturing, operational, maintenance or disposal phases, they should be formally tracked using a database that can be maintained for the operational life of that weapon system. This information is required to ensure the identification of adequate precautions, as well as the development of appropriate handling, transportation, storage, and disposal information.

As in the preliminary design/prototype phase, an environmental impact assessment should be completed or updated. The impact on the environment should be known prior to making any decisions.

Based on the environmental compliance assessment and the issues that have arisen as a result, specific environmental requirements should be developed and incorporated into the production contract language.

Detail Design/Pre-Production Model Checklist

✓	Actions
	1. Integrate pollution prevention projects from the preliminary design phase.
	2. Integrate environmental considerations into the contractor's decision management documents, life cycle assessment, life cycle cost, and risk management analyses.
	3. Review environmental compliance assessment from the previous acquisition phase and revise to ensure any new environmental constraints are identified.
	4. Update the pollution prevention program based upon the revised environmental compliance assessment and any new technologies that provide significant paybacks.
	5. Track all hazardous material identified for use in manufacturing, operations, maintenance, and disposal phases.
	6. Ensure an environmental impact assessment is completed prior to making decisions on weapon system testing.
	7. Review and update disposal plans.
	8. Incorporate environmental requirements into the configuration management and logistics support activities through contract language.
	9. Incorporate environmental requirements into the production contract language based upon pollution prevention, hazardous materials management, and other programs.

V-22 Fire Suppression System

The V-22 tiltrotor aircraft is designed to replace various U.S. Marine Corps, Navy and Air Force medium-lift helicopters. During the preliminary design phase of the program, the system was designed to use a halon 1301 fire suppression system. Prior to the detail design phase, the decision was made that the final aircraft system should not be dependent on an ozone-depleting fire suppression system; therefore, a joint government/contractor (Bell Helicopter and Boeing) effort was established to design, develop, and test an ODS-alternative.

Upon completion of a research, development, testing, and evaluation program, halon was replaced with non-ozone-depleting HFC-125 (pentafluoroethane) in the aircraft's engine nacelle compartments, and with a solid gas generator propellent in the mid-wing area.

In addition to eliminating halon 1301 in the mid-wing and engine nacelles, it was also eliminated as an extinguishing agent in portable aircraft fire bottles. Fire bottles utilised in the V-22 employ carbon dioxide (CO_2). Although CO_2 contributes to the "greenhouse" effect, the amount of CO_2 discharged from hand-held extinguishers over the life cycle of the system will be negligible.

Mobility Improvements in Tracked Vehicles

The terrain conditions in northern Sweden present severe mobililty problems for off-road vehicles. In wintertime, snow depths of more than one meter make it difficult for most vehicles to maneuver. In summertime, there are vast areas of marshlands that create similar mobility problems.

Because northern Sweden has very few roads, vehicles with special mobility characteristics had to be developed for the Swedish Armed Forces. Of these special vehicles, the all-terrain BV 206 is the most known. The Hägglunds Vehicle BV 206 is designed to have over-snow capacity mainly due to a very low ground pressure in combination with articulated steering. Tactical demands have been integrated in an environmentally friendly design owing to research on interaction between tracks and ground. The design of BV 206 minimizes wear and tear on the easily damaged ground in nothern Sweden.

Exercises with armored vehicles inevitably means problems with ground degradation due to tracks. Hägglunds CV 9030 Infantry Fighting Vehicle, in spite of its 25 ton weight, was designed to maximise the toughest demands on off-road mobility while decreasing the impact on the ground. The extremely low impact of the Hägglunds CV 9030 is achieved by low ground pressure, which minimises vehicle sinking and slipping. The low pressure design also made it possible to avoid the need for a low draw-bar pull, a feature that reduces traction in marshland and snow and causes heavy cuts in the ground.

The CV 9030 and BV 206 show that mobility and environmental performance can be substantially improved in the detail design phase. The revised properties of these vehicles were reached with the help of theoretical analysis and practical vehicle testing.

The Hägglunds Vehicle BV 206

The Hägglunds Vehicle CV 9030

Production and Deployment

The objective of this phase is to achieve the operational capabilities that satisfy the mission need. The extent of any design changes are usually a result of deficiencies that were identified during the testing in the previous phase. Because there is very limited opportunity to affect the system design, the environmental emphasis should reside primarily in the development of the logistics support procedures. In the previous phase, the program may have initiated material substitutions that are focused on maintenance materials. The program should also monitor the tremendous number of research and development programs that focus on the identification of material substitutions for a variety of weapon system applications. The results of these programs should be evaluated for incorporation into the maintenance processes.

The environmental compliance assessments performed in the previous two phases should be revised to ensure that any new environmental constraints are identified. Based on new compliance requirements, the pollution prevention strategy may also need modification. This may be due to the identification of new technologies that provide significant paybacks over the life cycle of the weapon system. The program manager should evaluate new initiatives and modify the funding requirements where appropriate.

Bradley Fighting Vehicle System (BFVS) Model A3: Material Substitution In Low Rate Initial Production

During the readiness review just prior to the low rate initial production of the BFVS Model A3, members of the BFVS Environmental Management Team started reviewing technical manuals and depot maintenance work requests to identify required uses of hazardous materials. The identified uses were analysed and alternatives to these hazardous materials were identified.

In addition to the effort to identify less hazardous substitute materials for maintenance of the weapon system, the prime contractor for the BFVS A3 began developing a baseline list of hazardous materials used in the manufacturing of the BFVS and entering them into a Hazardous Materials Database (HMD). Materials identified in the HMD were then researched and evaluated for their hazard severity and probability of release, and ranked in terms of high, medium, or low environmental hazard. Higher ranked materials were targeted first for material substitution.

In addition to the effort at the prime contractor's manufacturing facility, the prime contractor began a review of hazardous materials used by multiple major subsystem contractors.

As a result of these efforts, the following material substitutions were made at the beginning of the production process:

- Replaced volatile organic compound (VOC) solvents and adhesives used for application of thermal insulation liners with pre-applied, pressure-sensitive adhesives containing no VOCs.
- Replaced methyl isobutyl ketone (used for paint thinning and clean-up) with VOC-exempt thinners.
- Eliminated sealant used for hull armor plate application.
- Substituted less hazardous materials for acetone, methyl ethyl ketone, methylene chloride, and ethylene glycol used by a major subsystem contractor.
- Replaced zinc chromate with zinc nickel.
- Eliminated cadmium in metal-finishing processes.
- Substituted lead-free solder in radiators.
- Replaced ozone-depleting solvents with petroleum-based and aqueous-based cleaners.

JAS Gripen Aircraft

When JAS 39 Gripen series 1 was first delivered to the Swedish Armed Forces, it was painted with a conventional coating that consisted of about 50% organic solvents. The coating had low ability to attach to the surface and was hard to handle. During the production of the Gripen, Saab worked with a paint manufacturer to develop a new water-based coating that was useful for both military and civilian applications. The new coating consisted of about 45% water and less than 4% organic solvents. It turned out to be easier to apply, safer for humans, better the environment, and less expensive. The new paint has also a better surface adhesion compared to the older one.

The new coating was tested on the Gripen series 1 and found to be very successful. Series 2 is now delivered with the new coating and the older ones will gradually be repainted.

Saab has successfully carried out work regarding replacement of ozone-depleting substances (ODSs). In 1994, the company phased-out the last use of ODSs in the manufacturing of Gripen and other military equipment. Saab also phased out ODSs and implemented alternative materials for cleaning operations, release agents, and a number of other materials containing ODSs. The alternatives have created a better working environment and are comparable technically and economically to the previously-used materials which were based on ozone-depleting CFC and 1.1.1-trichloroethane.

Since 1992, Saab also has carried out research and testing to find alternatives for cadmium plating (of steel), which is an environmental problem during cleaning and maintenance of aircraft. One alternative they discovered is a new zinc-alloy, Zn-Co-Fe. After much testing and consideration, Saab, together with other aircraft manufacturers in Europe, found that this alloy had similar or better performance than cadmium plating in some applications. Therefore, Saab decided to implement this alloy for the manufacturing of military aircraft and reduced the use of cadmium in the workshop by 70-80%.

Production and Deployment Checklist

✓	Actions
	1. Concentrate on logistics support procedures for the weapon system. Ensure that hazardous material substitutions are incorporated in maintenance processes.
	2. Integrate environmental analyses and life cycle cost analyses into the maintenance concept planning and documentation.
	3. Conduct another review of the environmental compliance assessments from the previous acquisition phases and revise to ensure any new environmental constraints are identified.
	4. Update the pollution prevention program based upon the revised environmental compliance assessment and any new technologies that provide significant paybacks.
	5. Continue to update the hazardous material tracking system for the weapon system based upon development of maintenance and operations procedures.
	6. Ensure the production contractor continues to review hazardous material use requirements for production, with an eye on continuous improvement through a hazardous materials management program.
	7. Ensure an environmental impact assessment is completed and mitigating actions identified based upon specific deployment site options prior to making final decisions.
	8. Continue to review and update disposal plans.
	9. Incorporate environmental requirements into follow-on production contract language based upon pollution prevention, hazardous materials management, and other programs.

Operation and Maintenance

The objective of this phase is to have an effective support program that ensures sustainment of the weapon system in the most cost-effective manner. Because there are many environmental cost drivers in the operation and maintenance of the weapon system (e.g., personnel protective equipment, operating permits, hazardous waste disposal, etc.), it is important to continue the environmental strategy that was developed and implemented in the previous phases of the program. A methodology should be established to facilitate feedback on environmental issues and concerns from the operators and maintenance personnel to the weapon system program office.

The program should also continue the environmental compliance assessment performed in the previous three phases, to ensure that any new environmental constraints for the program are identified. Based on new compliance requirements, the program may need to implement new pollution prevention initiatives at the facility level, as well as potential engineering changes to the weapon system.

F/A-18, E-2, and S-3 Aircraft: Elimination of Ozone-Depleting Solvents at Depot-Level Maintenance

At the aviation depot primarily responsible for the F/A-18, E-2, and S-3 aircraft, precision instrument bearings were cleaned using the ozone-depleting solvents CFC-113 and 1,1,1-trichloroethane in a vapour degreasing process. Realising the environmental hazards posed by this cleaning process, the depot began an effort to eliminate these solvents.

After conducting research and carrying out a test program, two alternative cleaning systems were identified for precision bearing cleaning. One system consists of a low emission isopropyl alcohol (IPA) degreaser/dryer. The second system is an advanced, 3-sump, superheated vapour degreaser using IPA and cyclohexane. Implementing these two systems eliminated ozone-depleting solvents and also reduced annual solvent emissions from several thousand pounds to less than 500 pounds. In addition, initial implementation costs for the new systems were paid back in less than one year by cost savings generated from the new systems.

After the initial implementation costs were paid back, annual cost savings for the two systems is estimated at $284,000 USD.

Operation and Maintenance Checklist

✓	Actions
	1. Establish a method to provide feedback from the operators and maintenance personnel to the weapon system program office on environmental issues and concerns.
	2. Implement new pollution prevention initiatives at the facility level, as well as engineering changes to the weapon system if necessary to meet new compliance requirements.
	3. Continue to update the hazardous material tracking system for the weapon system based upon modifications of maintenance and operations procedures and engineering changes.
	4. Continue to update and review disposal plans.
	5. Incorporate environmental requirements into follow-on production, engineering, and support contract language based upon pollution prevention, hazardous materials management, and other programs.

Demilitarisation, Reuse, and Disposal

Many systems, components, equipment, and materials removed from weapons systems undergoing disposal require demilitarisation, particularly if they have not been targeted for reuse by other military activities. Demilitarisation requires the concealment of operational characteristics, classified components/systems, unclassified hardware of known foreign intelligence interest, failure mechanics, advanced technology, and other sensitive war-fighting capabilities of items being removed from the platform. Other less sensitive items may simply need to be removed from the components themselves (i.e., tags, name plate data, stickers or labels), so as not to reveal operational parameters.

As mentioned above, many components from older systems may be targeted for reuse by other activities. The weapon system acquisition manager should have a recycling/re-use program in place (developed during the design phase). This initiative could reap substantial procurement cost savings and also preclude the disposal of viable components. Recycled components can also be utilised by the supply infrastructure as spare parts for other in-service weapon systems.

Disposal, in accordance with applicable environmental requirements, should only involve those materials that could not be reused or otherwise managed. Hazardous waste and other scrap materials should be properly removed from the platform, and worker safety and health concerns should also be addressed. Waste materials should be properly packaged and labelled for identification, tracking, storage, transportation, and handling purposes. Finally, proper disposal (i.e., landfill, incineration, purification, etc.) should be accomplished in accordance with applicable environmental requirements.

Swedish Coastal Artillery Fortresses

Several environmental considerations have to be made when disposing of old coastal artillery fortresses. During 1994-1996, the Swedish Armed Forces undertook a pilot project to dispose of an old fortress. Two separate environmental impact assessments involving the whole fortress and surrounding establishments were performed. The Swedish environmental authorities and local civilian authorities participated in the project. The equipment and support installations were dismantled and then either reused, sold, or disposed of. Decisions were made together with the environmental authorities about what to do with the components of the fortress and what environmental aspects should be considered. It was decided that some of the equipment could be left at the site, and a research project was established to evaluate the environmental impact from heavy metals in cables and other components left at the site. The surrounding area was remedied. The remaining fortress was sealed with armoured concrete to make it impossible to reopen. The total cost of the project was $1 million USD and the estimated avoided future environmental costs were approximately three times higher in a decade.

Swedish Submarine Batteries

Conventional submarines use very large lead-acid batteries while they are at sea. These batteries can be as large as 10-20% of the total submarine displacement and feature hundreds of tons of heavy metals, acids and other materials. In addition, they have a limited lifetime of five to eight years.

Whether a battery is purchased for a new Swedish submarine, or whether an existing battery is being replaced, plans are already made for the recycling and destruction of the battery's materials and components. These plans are part of the commercial deal with the manufacturer and in co-operation with Swedish environmental authorities. All metals are recycled and used again either for new batteries or for other industrial uses, and the acids are neutralised before disposal. Plastic and rubber materials are taken care of according to the established and approved routines.

Aerospace Maintenance and Regeneration Center (AMARC): Storage and Recycling of Aircraft

AMARC was developed as a central storage, regeneration, and reclamation facility for U.S. Department of Defense (DOD) aircraft. Aircraft that are placed out of service by DOD are sent to AMARC for storage and/or reclamation. AMARC then serves as a centralised point for DOD and other customers to obtain spare parts or entire flyable aircraft. By recycling these aircraft, environmental impacts as a result of disposal or production of new spare parts are avoided.

In fiscal year 1996, AMARC received 572 aircraft and processed 453 into storage. In that same year, AMARC returned 125 aircraft and 21,307 parts to the government for a total output of $861 million USD. Considering AMARC's budget was $51 million, this represents a return on investment of $17 for each $1 spent.

Demilitarisation, Reuse, and Disposal Checklist

✓	Actions
	1. Review demilitarisation, reuse, and disposal plan to ensure all environmental requirements are up to date.
	2. Prior to deciding to dispose of the weapon system or components, ensure that all components and spare parts have been evaluated for potential recycling and reuse. Also, ensure that all potential "re-users" have been notified of disposal plans.
	3. Ensure than an environmental impact assessment that addresses the environmental impacts of disposal is complete.
	4. Ensure that disposal contracts and plans clearly communicate hazardous material removal, handling, and disposal procedures, as well as worker safety procedures.

Chapter 5: Tools and Methods

The previous chapter of this handbook provides details on the environmental actions that should be conducted during the different phases of the acquisition process. This chapter describes some of the management and analytical tools that can be used to accomplish these actions. The figure below illustrates the use of these tools in a typical acquisition process. It is not unusual, however, for many of the tools to be used—at least conceptually— throughout the entire acquisition.

It is not possible to give a complete description of all the tools and methods relevant to environmental planning and management. Therefore, the aim of Chapter 5 is to give the project manager the means to select adequate tools and find relevant references. Tools in this document are provided as resources for the program manager. Acquisition program managers should follow the guidance of their individual governments as to which tools are required and recommended for use.

QUICK REFERENCE GUIDE
Tools Covered in this Chapter

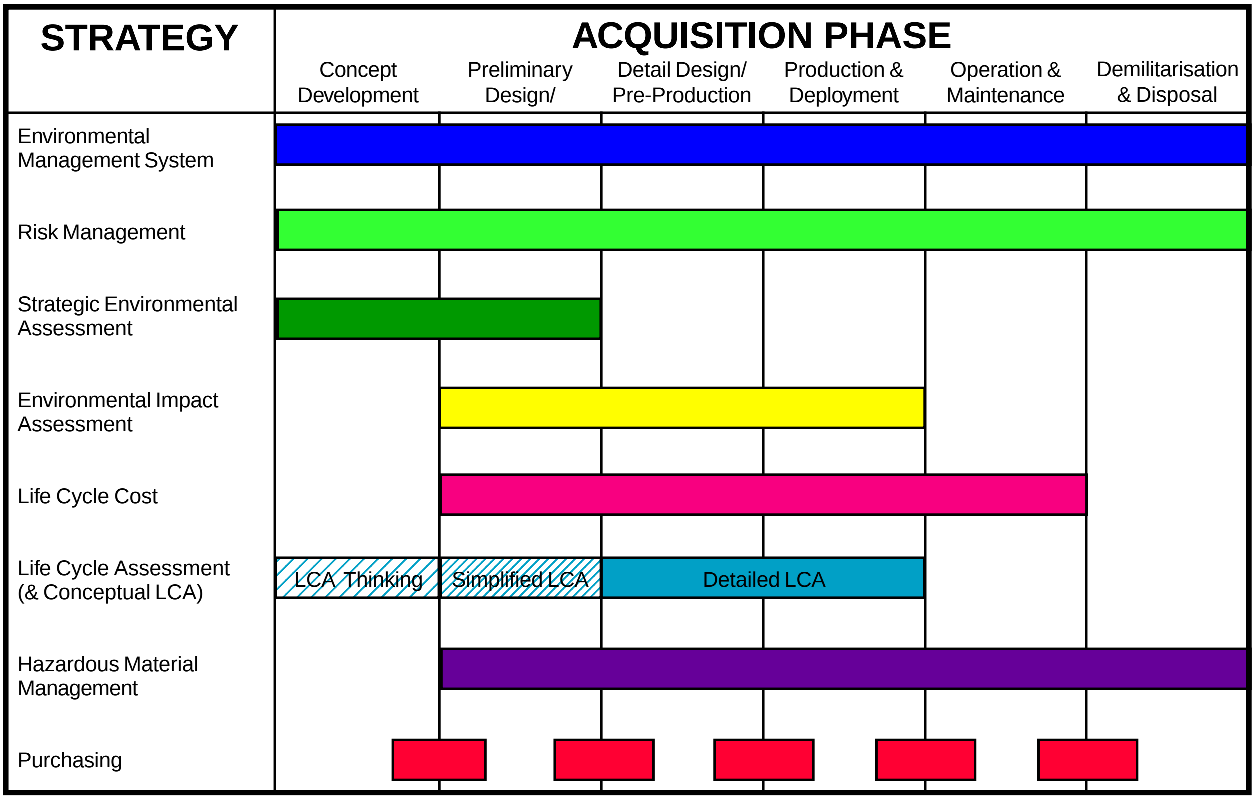


Figure 5.1: Tools Chart

Management

Taking into account their own environmental policies and objectives, organisations of all kinds are increasingly concerned with achieving and demonstrating sound environmental performance by controlling the impacts of their activities, products, or services on the environment. From the beginning of an acquisition program and continuing throughout the weapon system's life cycle, an environmental management system (EMS) should be utilised. An EMS provides an organised manner in which to assess, manage, monitor, and improve environmental performance. Two examples of EMSs are ISO 14001 (an international EMS standard) and EMAS (a European EMS standard). Details on the two standards are provided below.

ISO 14001

The International Organisation for Standardisation (commonly referred to as ISO) standard, "Environmental Management Systems - Specification with Guidance For Use" (ISO 14001:1996) is intended to assist organisations in achieving their environmental and economic goals. The standard was written to be applicable to all types and sizes of organisations, and to accommodate diverse geographical, cultural, and social conditions. The basis of the approach is shown below. The success of the system depends on commitment from all levels and functions, especially from top management.

ISO 14001 contains only those requirements that may be objectively audited for certification/registration purposes and/or self-declaration purposes. Those organisations requiring more general guidance on a broad range of environmental management system issues should refer to ISO 14004:1996, Environmental Management Systems - General Guidelines on Principles, Systems and Supporting Techniques.

The ISO 14000 standards series also includes the following environmental standards:

- ISO 14010 Guidelines for Environmental Auditing - General Principles
- ISO 14011/1 Guidelines for Environmental Auditing - Audit Procedures - Auditing of Environmental Management Systems
- ISO 14012 Guidelines for Environmental Auditing - Qualification Criteria for Environmental Auditors
- ISO 14015 Environmental Site Assessments
- ISO 14020 Goals and Principles of all Environmental Labelling

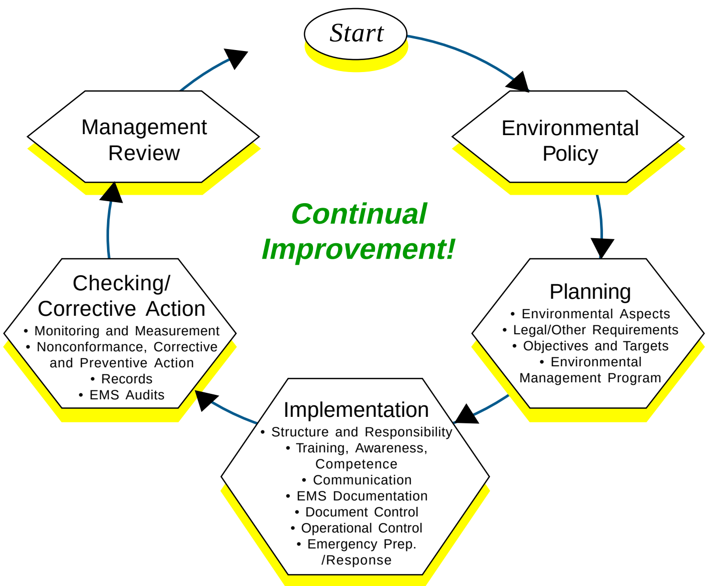


Figure 5.2: Elements of an Environmental Management System

- ISO 14021 Environmental Labelling - Self Declaration Environmental Claims - Terms and Definitions
- ISO 14022 Environmental Labelling - Symbols
- ISO 14023 Environmental Labelling - Testing and Verification Methodologies
- ISO 14024 Environmental Labelling - Guiding Principles, Practices and Criteria for Multiple Criteria-Based Practitioner Programs (type I) - Guide to Certification Procedures
- ISO 14025 Type III Labelling
- ISO 14031 Evaluation of Environmental Performance
- ISO 14040 Life Cycle Assessment - Principles and Guidelines
- ISO 14041 Life Cycle Assessment - Life Cycle Inventory Analysis
- ISO 14042 Life Cycle Assessment - Impact Assessment
- ISO 14043 Life Cycle Assessment - Interpretation
- ISO 14050 Terms and Definitions - Guide on the Principles for ISO/TC 207/SC Terminology Work

The following World Wide Web sites provide additional information on ISO 14001:

- International Organisation for Standardisation web site - **http://www.iso.ch/**.
- U.S. Defense Environmental Network Information Exchange (DENIX) web site - **http://www.denix.osd.mil/denix/Public/Library/ISO14000/iso14000.html**.

Environmental Management Systems (EMSs) in Swedish Defence

In 1993, the Swedish Armed Forces started to develop a formal environmental plan. In 1996, it was extended to adopt an Environmental Management System using ISO 14001 as a source. The Swedish government decided early to implement an environmental policy for the armed forces and conducted an environmental investigation concerning the entire armed forces. Environmental plans were produced on all levels, consisting of programs and a schedule for the activities. Environmental Officers have been appointed to every unit, and they are given environmental education at University level. An environmental handbook for the armed forces has been written, and many control programs and checklists for different environmental actions have been produced. The Supreme Commander annually gives a public environmental account and provides a special environmental report to the Swedish government. In addition, every local unit gives reports to the local environmental authorities.

FÖRSVARSMAKTEN
HÖGKVARTERET

As a result of the increasing demands for environmental care and the cooperation with the Armed Forces, the Swedish Defence Materiel Administration started a project in 1997 to improve environmental awareness in the acquisition process by implementing an environmental management system. The chosen system is based on ISO 14001, EMAS, and “Environmental Guidelines for the Military Sector,” a publication produced by the North Atlantic Treaty Organisation (NATO).

Using an environmental review as a basis, several environmental objectives were identified. The objectives were transformed into environmental targets that focused primarily on improved environmental awareness through education.

Eco-Management and Audit Scheme (EMAS)

Another environmental management system currently being used in the European community is the Eco-Management and Audit Scheme (EMAS). EMAS is a voluntary system for industrial companies that seek to reward and promote better environmental performance of industrial activities. The scheme is very similar to ISO 14001 in that it requires participating sites to establish and implement policies, programs, and management systems, and audit the performances of their sites. One difference between EMAS and ISO 14001 is that EMAS also requires organisations to provide environmental performance reports to the public.

EMAS applies to manufacturing, energy, and recycling industry sites, and may be extended to other sites on an experimental basis. Companies that want to join EMAS must:

- adopt an environmental policy that outlines the objectives and principles of its environmental actions;
- conduct an environmental review of the site;
- introduce an environmental program for the site, specifying the objectives and measures to be taken to implement the policy;
- introduce an environmental management system; and
- carry out regular environmental audits and make an environmental impact statement.

All of the above must be examined by an accredited environmental verifier independent of the company.

National or international environmental management and audit systems other than the EMAS may be considered as equivalent if they are identified in the Official Journal of the European Community.

Additional information on EMAS can be found at the European Union Community Eco-Management and Audit Scheme web site at **http://europa.eu.int/comm/sg/scadplus/leg/en/lvb/l28022.htm**.

Risk Management

The risk management process is intended to identify, assess, and eliminate or reduce risk (including environmental risk) in areas that represent a threat to the successful design, construction, operation, support, and eventual disposal of the weapon system and its components. Each person involved with the design, construction, operation, support, and eventual disposal of any part of the system or component should be a part of the risk management process. The true challenge of a risk management process is using tools to help identify those unknowns that must be dealt with to avoid adverse consequences.

The Risk Management Process

The process includes four steps as shown in Figure 5.3:

Step 1 - Risk Identification

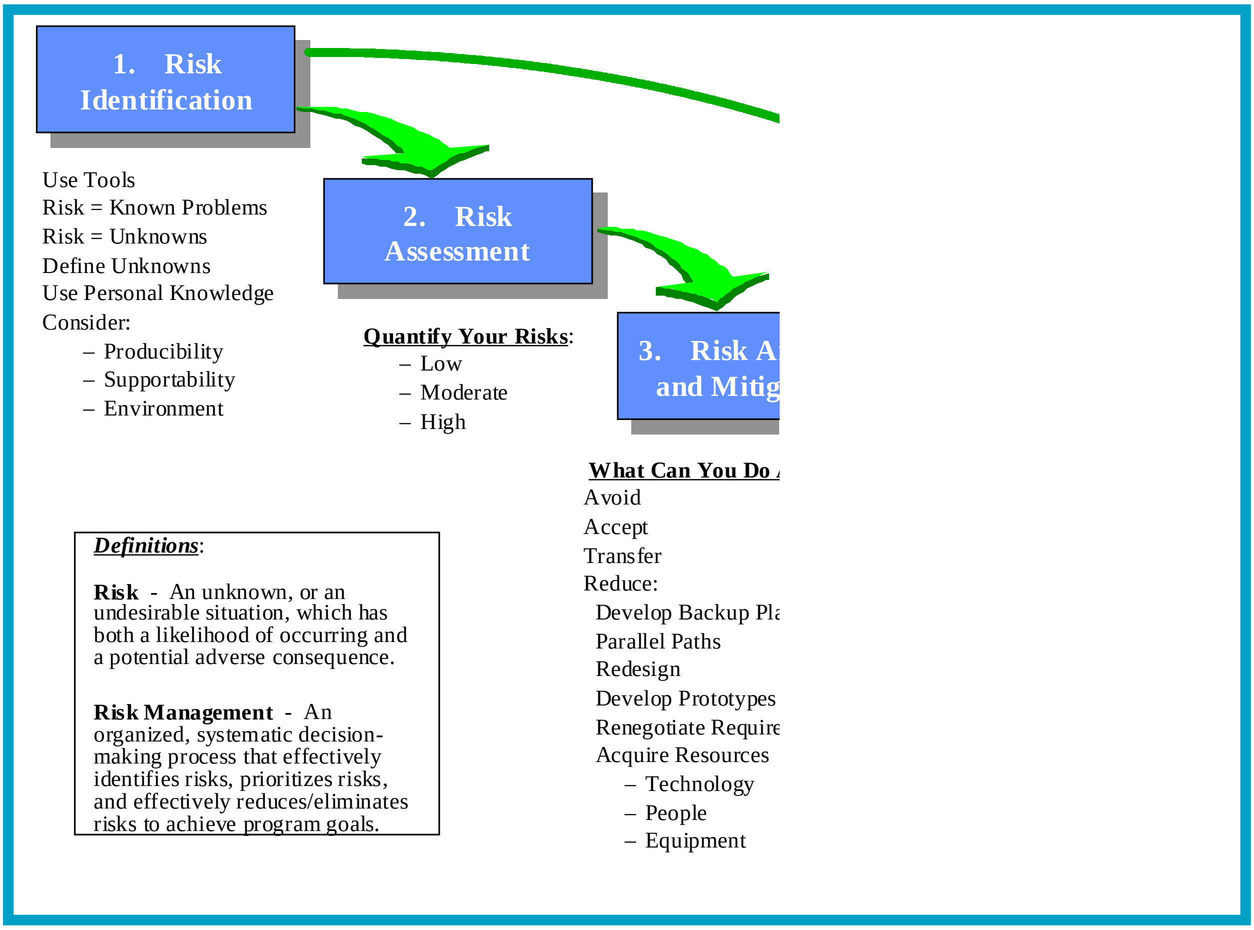
The purpose of Step 1 is to record risk areas considered to be of highest priority. To determine whether any are MODERATE or HIGH risk, go to Step 2, "Risk Assessment."

Step 2 - Risk Assessment

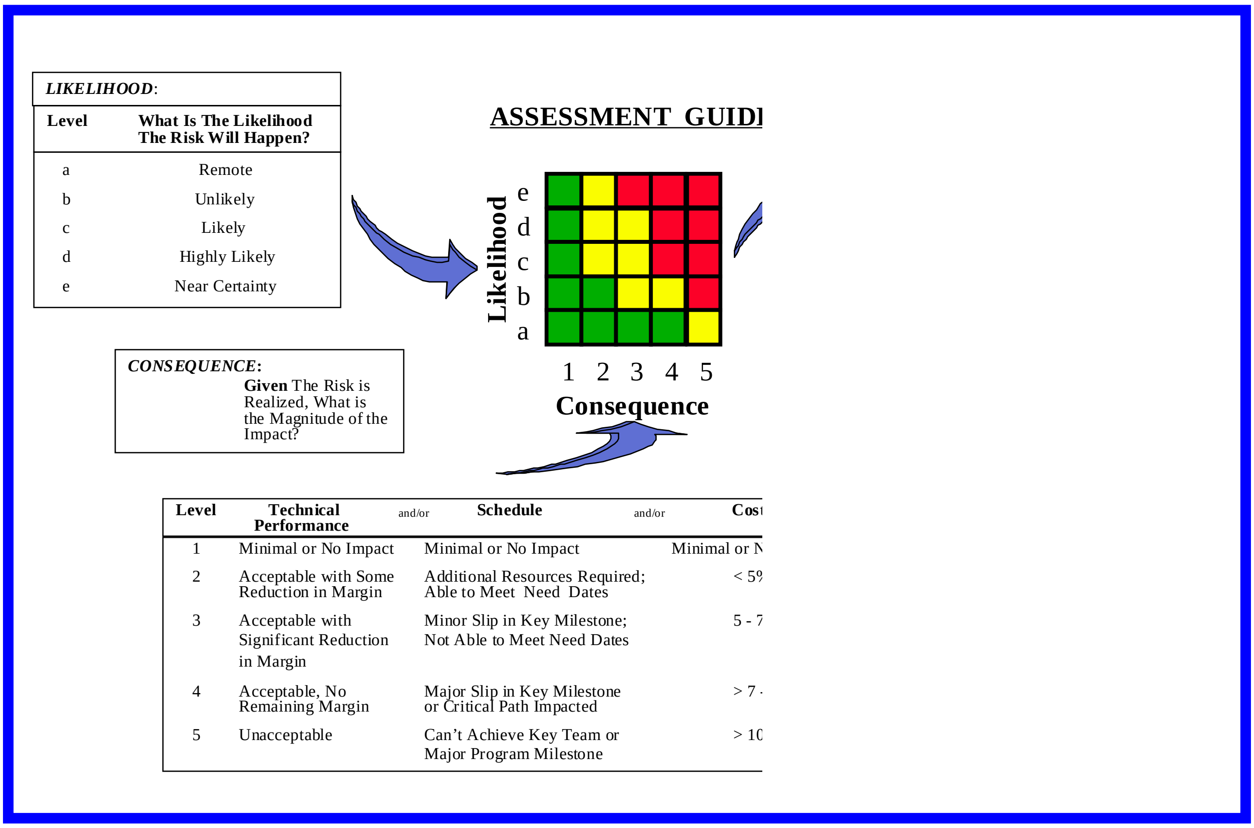
For each identified risk area, the program managers must determine the likelihood of risk, and the consequence of each risk. Risk consequence is evaluated by answering the following question: "Given the risk is realised, what is the magnitude of the impact?" Gradations of consequence are labelled one through five and correspond to the x-axis on the Assessment Guide (Figure 5.4).

"Consequence" is a multifaceted issue. To assist with determining the level of consequence, four metrics can be chosen: Technical Performance, Schedule, Cost, and Impact on Other Teams. At least one of the four consequence metrics needs to apply to be considered a risk.

At the end of Step 2, the risk areas (identified in Step 1) which were assessed as MODER-



▲ *Figure 5.3: Risk Management Process* ▼ *Figure 5.4: Risk Assessment Guide*



LIKELIHOOD:	
Level	**What Is The Likelihood The Risk Will Happen?**
a	Remote
b	Unlikely
c	Likely
d	Highly Likely
e	Near Certainty

Level	**Technical Performance**	and/or	**Schedule**	and/or	**Cost**
1	Minimal or No Impact		Minimal or No Impact		Minimal or N
2	Acceptable with Some Reduction in Margin		Additional Resources Required; Able to Meet Need Dates		< 5%
3	Acceptable with Significant Reduction in Margin		Minor Slip in Key Milestone; Not Able to Meet Need Dates		5 - 7
4	Acceptable, No Remaining Margin		Major Slip in Key Milestone or Critical Path Impacted		> 7 -
5	Unacceptable		Can't Achieve Key Team or Major Program Milestone		> 10

ATE or HIGH, should be submitted without delay to the appropriate Risk Area Manager or entered directly into a Risk Database.

Step 3 - Risk Analysis and Mitigation

Develop specific tasks that, when implemented, will reduce the stated risk to an acceptable level. Describe what has to be done, the level of effort needed, and the material or facilities required. Provide a proposed schedule to accomplish the actions and, if possible, provide a cost estimate. List all assumptions used in the development of the mitigation plan.

The output of Step 3 is the addition of mandatory field information required to add mitigation plans to the Risk Assessment added in Step 2.

Step 4 - Risk Tracking

MODERATE- and HIGH-risk areas shall be reported to the Risk Area Manager and entered into the Risk Database or registered in another appropriate way.

Risk should be made an agenda item at each management or design review. Openly discussing risk provides an opportunity for all concerned to offer suggestions for the optimum approach to reducing risk to an acceptable level. Communicating risk improves the system's credibility and allows early actions to minimise adverse consequences.

Risk Management Organisation

Risk management should be appropriately included in the project organisation plan of the whole acquisition process.

The risk manager should work closely with the program manager. In addition, all members in the project should get a general education in risk management to be sure that all situations would be handled in a proper way.

Analysis

Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA)

Since environmental issues have become important in planning process, many different methods have been used to conduct an Environmental Impact Assessment (EIA). In this handbook, EIA is being used as a general term to include all environmental analyses used to support decision-making, producing such documents as Environmental Assessments and Environmental Impact Statements. Today, countries in Europe and North America are using EIAs as tools to accomplish sustainability and, alternatively, sustainable development. There are big differences in the ways these methods are used, and some countries have legislation on the EIA process. Program managers should always follow specific regulations of their country on the use of these analyses.

The purpose of an EIA is to analyse and to make a prognosis of environmental consequences for different solutions. An EIA can be characterised as a multidisciplinary and predictive analysis. In its most usual manifestation, it is closely linked with the planning system. The outcome of the EIA will usually result in a formal document, which is used as a basis for decision making. To date, EIAs have primarily been carried out for projects such as power stations, industrial installations and housing developments. In the defence sector, EIAs are typically used to assess the impacts of weapons testing during design, production, deployment, maintenance, and disposal.

The Strategic Environmental Assessment (SEA) is a natural extension of the EIA on a more strategic level - policies, plans, and programs. SEAs emphasise early environmental considerations in the planning process during the concept development and preliminary design phases. They also promote the idea of generating alternative solutions to obtain the objectives instead of variations on one alternative. The SEA could, therefore, be used in the concept development phase as well.

EIAs and SEAs constitute processes which analyse the environmental effects that will arise from a given plan of action. Performing an EIA or SEA can be described as a process where the first step is to analyse the current situation regarding the environment. The next step is to generate and examine different alternatives - to obtain the desired effect - stated in the plan. Different alternatives have a unique impact on the environment. These impacts should be estimated for all alternatives, considering all relevant environmental parameters.

The difference between the two states - before and after implementing an alternative - brings out an environmental impact for that particular alternative. The next step is to find different mitigation measures for the different alternatives. After this process, a document called an Environmental Impact Statement (EIS) is produced. An EIS describes all the alternatives and serves as a basis for selecting the alternative.

For a comprehensive description, please refer to "Environmental Impact Assessment, Theory and Practice" (Wathern, 1992).

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"EIA can be described as a process for identifying the likely consequences for the biogeophysical environment and for man's health and welfare of implementing particular activities and for conveying this information, at a stage when it can materially affect their decision, to those responsible for sanctioning the proposal." (Munn, 1979)

◆◆◆

An EIA, in itself, cannot provide comprehensive protection of the environment for several reasons. First, it reacts to development proposals rather than anticipating them. Second, it does not adequately consider the cumulative impacts of more than one project. However, the SEA can be used as a proactive step towards attaining sustainability. A guide to SEAs is found in "Strategic Environmental Assessment" (Therivel, Wilson, Thompson, Heaney and Pritchard, 1992).

The steps of an SEA

1. Determine the need for an SEA

First, there has to be a decision whether an SEA is needed or not. In some cases, the SEA is required by legislation. However, certain factors–such as unique environmental features–can be identified that would suggest that an SEA should be carried out.

2. Establish a work program

It is essential to establish a work program for the SEA. First, the goals of the SEA should be addressed. This also includes a description of issues and problems that could be anticipated. Together with a timetable and budget, the work program should also include a list of co-operating agencies and a staffing plan.

3. Determine the objectives of the policy, plan, or program

A clear understanding of the objectives of the policy, plan, or program is important for carrying out the SEA.

4. Define the scope of the SEA

The scoping process reviews all environmental impact categories and how they might be affected, as well as the amount of attention to be given to the analysis of potential impacts. It is also required to identify the physical and regional limits of the assessment of the impacts that it will address, and the possible alternatives it will cover. It must also consider constraints such as legislative requirements, the need for mitigation or compensation, and the views of the public and relevant organisations.

The process of identifying relevant impacts to be addressed in the SEA could include the use of checklists, a review of existing data, a comparison with alternative options to highlight any significant impacts, and the circulation of a preliminary list of impacts to staff and/or the public for an interdisciplinary review of the issues.

5. Conduct an environmental analysis

After agreeing to the scope of the SEA, baseline data are collected, impacts are predicted, their significance is evaluated, and mitigation measures are proposed. Knowledge of the baseline situation is a necessary reference point that is used to predict and then monitor any environmental change that may occur. It is essential that provisions for assembling baseline data and data collection are initiated at an early stage in the process.

6. Establish an environmental database

A database will need to be established to organise the large amounts of information generated and manipulated during impact analysis, synthesis, evaluation, and monitoring.

Geographical Information Systems (GIS) can be particularly useful in modelling and predicting changes to the environment. GIS files could be used as part of the SEA report, to allow alternative options to be compared.

7. Evaluate the impacts

Evaluation of the impacts of various alternative options should take into account not only raw data, but also other considerations necessary to interpret and evaluate the data. These include regulatory standards, government guidance, the attitudes and preferences of residents, and the effectiveness of public planning and management in mitigating potential impacts.

8. Propose recommendations and prepare an SEA report

Recommendations will be derived from the findings of the impact evaluation. These may include:

- Identification of a preferred alternative;
- Mitigation measures; and
- Monitoring measures that may be necessary.

A formal SEA report should then be prepared and made available, documenting the findings of each stage of the process. Distinctions should be made between short-term and long-term impacts, as well as reversible and irreversible impacts.

9. Monitoring and feedback

Finally, monitoring will be needed to evaluate the effects of the policy, to identify further studies and modifications needed during implementation, and to assist in future decision making. It is important to check the extent to which the assumptions and forecasts in the SEA have turned out to be valid.

References:

Munn, R.E., 1979: *Environmental Impact Analysis. Principles and Procedures*, 2nd ed. [SCOPE (report no. 5)], Wiley, Chicester.

Therivel, R., et. al., 1992: *Strategic Environmental Assessment*, Earthscan Publications Ltd., London.

Wathern, P., 1992: *Environmental Impact Assessment, Theory and Practice*, Routledge, London and New York.

Wood, C., and M. Djeddour, 1991: Strategic Environmental Assessment: EA of Policies, Plans and Programmes, *Bulletin of the International Association for Impact Assessment*,University of Manchester.

Programmatic Environmental, Safety and Health Evaluation (PESHE)

The version of an SEA used by the United States military is called a Programmatic Environmental, Safety and Health Evaluation (PESHE). The PESHE describes the program manager's strategy for integrating Environmental, Safety, and Health (ESH) issues with the other essential elements of the program and for managing ESH issues as they become evident. The PESHE is initiated at the earliest time in support of the program initiation decision and is continually updated throughout the life cycle of the program, becoming increasingly more definitive as the program progresses.

The PESHE should state the program's ESH objectives; describe ESH requirements (or the process for establishing them); explain which program and contracting documents will be used to implement the strategy; discuss the program's approach for conducting the required ESH analyses; describe responsibilities of the government and contractor(s); and track progress. The PESHE should be concise and should address the following topics:

a. Describe when and how the program will perform Environmental Impact Analyses to support environmentally informed decisions between proposed alternatives. In the United States, this analysis is to meet the requirements of the National Environmental Policy Act and Executive Order 12114, and results in such documentation as the Environmental Assessment or Environmental Impact Statement.

Environmental Impact Assessment: The Airborne Laser Program

The U.S. Air Force is developing a more accurate and effective defence against mobile theatre ballistic missiles (TBMs) by destroying them during boost phase, just after launch, via a high-energy chemical oxygen iodine laser (COIL) to be carried aboard an aircraft.

The concept development phase of the program was completed with two competing vendors developing a basic system design. Prior to entering the preliminary design/prototype phase, an Environmental Impact Assessment (EIA) was prepared to evaluate the environmental impacts of prototype testing. The EIA evaluated several different test scenarios including a proposed and alternate home base; a proposed diagnostic test range and two alternative diagnostic test ranges; an expanded test range; and a no-action alternative.

The EIA included a wide variety of environmental impacts including:
- air quality
- biological resources
- geology, soils, and water resources
- cultural resources
- hazardous materials and waste
- health and safety
- land use
- noise
- socio-economics
- infrastructure and transportation

The Airborne Laser Program Office used the EIA for two purposes: 1) to determine environmental impacts, and 2) to utilise impact information to incorporate environmental considerations early in the design process.

The conclusion of the Airborne Laser EIA was that neither normal or emergency operations during the prototype test phase would have any long-term significant impact on the environment.

b. Describe how environmental compliance requirements for the system, support equipment, associated training, and operations and maintenance activities are established and managed; describe procedures for periodic review of compliance requirements; summarise important compliance issues; and analyse significant impacts on the program's cost, schedule, and performance.

c. Describe safety and health procedures used to identify, evaluate, eliminate, and control hazards; define risk levels; track progress; identify high risk hazards; and summarise the impacts of projected accidental loss in terms of lives and units lost to accidents.

d. Describe the hazardous materials program, goals, and issues, including the process for identifying, minimising use, tracking, storing, handling, and disposing of hazardous materials that can not be eliminated from the system.

e. Describe pollution prevention initiatives and goals and track progress. Describe process for identifying and preventing or minimising impacts to natural resources. Assess the potential for cost effectively using recovered and/or recycled materials, and environmentally preferable products (products and services that have a lesser or reduced effect on human health and the environment when compared with competing products or services that serve the same purpose).

References:

United States Department of Defense, 1996: Defense Acquisition, DOD Directive 5000.1.

United States Department of Defense, 1996: Mandatory Procedures for Major Defense Acquisition Programs and Major Automated Information Systems, DOD Directive 5000.2R.

Life Cycle Cost (LCC)

In recent years, the cost of weapon systems has risen both in terms of its initial acquisition cost and in terms of maintenance costs. This trend, in combination with tighter budgets, has increased interest in looking at the total life cycle cost of the system. Life Cycle Cost (LCC) is a method designed to meet these requirements. Another reason for using LCC is to take into consideration expenses due to environmental effects caused by use and maintenance of military equipment during its lifetime, and expenses due to disposal of equipment.

Briefly, the principle of LCC is that a decision should be based on all costs and sacrifices influenced by the decision. The purpose of the decision determines how LCC is to be used. Even if a formal LCC analysis is not carried out, it is advisable to apply LCC thinking when the issue is about system acquisition, operation, or maintenance.

LCC is a management tool used to:

- visualise and influence all costs occurring with a decision, including future operation and maintenance costs;
- analyse cost-consequences of different availability requirements for the system;
- identify and eliminate cost-increasing factors early on; and
- select a maintenance philosophy.

LCC can be used for different purposes:

- Analysis during the study phases leading to Tactical, Technical, and Economic Objectives - Choice between different systems.
- Choice of Contractor- Evaluation of proposals based on contractor's availability data, and then choice of contractor.
- Budget Forecasts- What kinds of expenses are to be anticipated, and how are they allocated to years during the lifetime of the system?
- Modifications- How long will the system be used? When is it to be modified or replaced?

The LCC analysis is not a one-time effort. On the contrary, it is advisable to regard the LCC analysis as a recurrent activity with an increasingly more detailed scope as the systems acquisition process proceeds from preliminary design through production and deployment.

While the use of LCC models for weapon system acquisition is now commonplace in many militaries, the inclusion of total environmental costs is a relatively new concept. Examples of environmental costs that should be included in the LCC model are:

- Acquisition costs
  - building construction
  - equipment
  - project engineering
- Operations and maintenance costs
  - labour
  - waste disposal
  - utilities
  - permitting
  - reporting
  - monitoring
  - manifesting
  - local waste management
  - pollution control
- Disposal costs
  - transport
  - waste disposal
  - permitting
  - reporting
  - monitoring
  - manifesting
  - pollution control
- Liability costs
  - insurance (if not indemnified by the national government)
  - penalties and fines
  - personal injury and property damage
  - natural resource damages
- Less tangible benefits/costs
  - increased or decreased performance from enhanced or degraded military image
  - reduced or increased health maintenance costs from improved or degraded employee health
  - reduced or increased productivity from improved personnel/employee relations

Since LCC models by definition may include only those parameters with a “cost” or “price”, it is sometimes necessary to postulate a “cost” for certain liabilities and less tangible parameters. For example, while a delay in fielding a weapon system due to environmental compliance enforcement actions or citizen legal suits may not result in significant monetary outlays, the reduction in military readiness that this delay causes may be postulated as a “fine” for the purposes of an LCC model. Since these postulated costs may be difficult to predict and estimate, any assumptions used to predict these costs should be detailed in LCC reports and should be agreed upon by program management.

Care should be taken when developing an LCC model in early acquisition stages to ensure that it accounts for entire life cycle of the weapon system. For example, in the past the costs to demilitarise or dispose of a weapon system were not considered. Since disposal of a weapon system may lead to considerable environmental effects, it is important to ensure that these effects are analysed and assigned costs in an LCC model as early as the concept development phase of the acquisition process.

References

Blanchard, B., 1974: *Logistic Engineering and Management*, Prentice-Hall, Englewood Cliffs, N.J.

Freeman, Harry, 1995: *Industrial Pollution Prevention Handbook*, McGraw-Hill, New York.

Pålsson, L., and O. Wååk, 1982: *An applied technique for LCC improvements - Case stories*, Swedish Defence Materiel Administration, Stockholm.

Life Cycle Costs and The Advanced Amphibious Assault Vehicle (AAAV)

The U.S. Marine Corps Advanced Amphibious Assault Vehicle (AAAV) program is using an acquisition strategy where total life cycle cost is a part of every design decision. Under this strategy, all design decisions are made based upon total ownership costs of the vehicle over its 20-year life span. By using a life cycle cost method instead of the older, more traditional initial development and procurement costing methods, it was determined that 60% of the ownership cost of the weapon system involved operations and support (O&S) costs. Among these O&S costs are environmental considerations such hazardous material use and waste disposal during maintenance.

When selecting materials for use on the AAAV, the program management team realised that life cycle costs, especially environmental costs, are not always accurately identified at the front end of an acquisition program. These cost oversights can quickly escalate the total costs of a program. To prevent this oversight, a list of materials that have adverse environmental impacts was assembled by the Program Office and augmented by the Contractor Team. For most of these materials, life cycle costs were calculated and an initial round of briefings was given to all the Integrated Product Teams on the impact of environmental considerations on life cycle costs. The environmental engineer and the safety engineer attempted to provide costs which are not taken into account in normal costing models.

Cadmium, for example, has long term costs which were included in the life cycle costing models for materials proposed for this program. Cadmium is a heavy metal that poses environmental problems, and is toxic. Those characteristics require special training, storage, inventory, packaging, management, care, and handling. These special requirements result in extra costs during demilitarisation, recovery, and disposal at the end of the useful life of a vehicle. Attempts to quantify all environmental costs were difficult. For example, it was very difficult to quantify clean-up costs for cadmium leaching contamination of rivers and streams. A multi-million dollar military clean up in North Carolina is proof of the high cost of using cadmium. However, the acquisition team extrapolated figures based on current fines and estimated clean-up cost avoidances. As a result of this effort, the decision was made to exclude cadmium from the program.

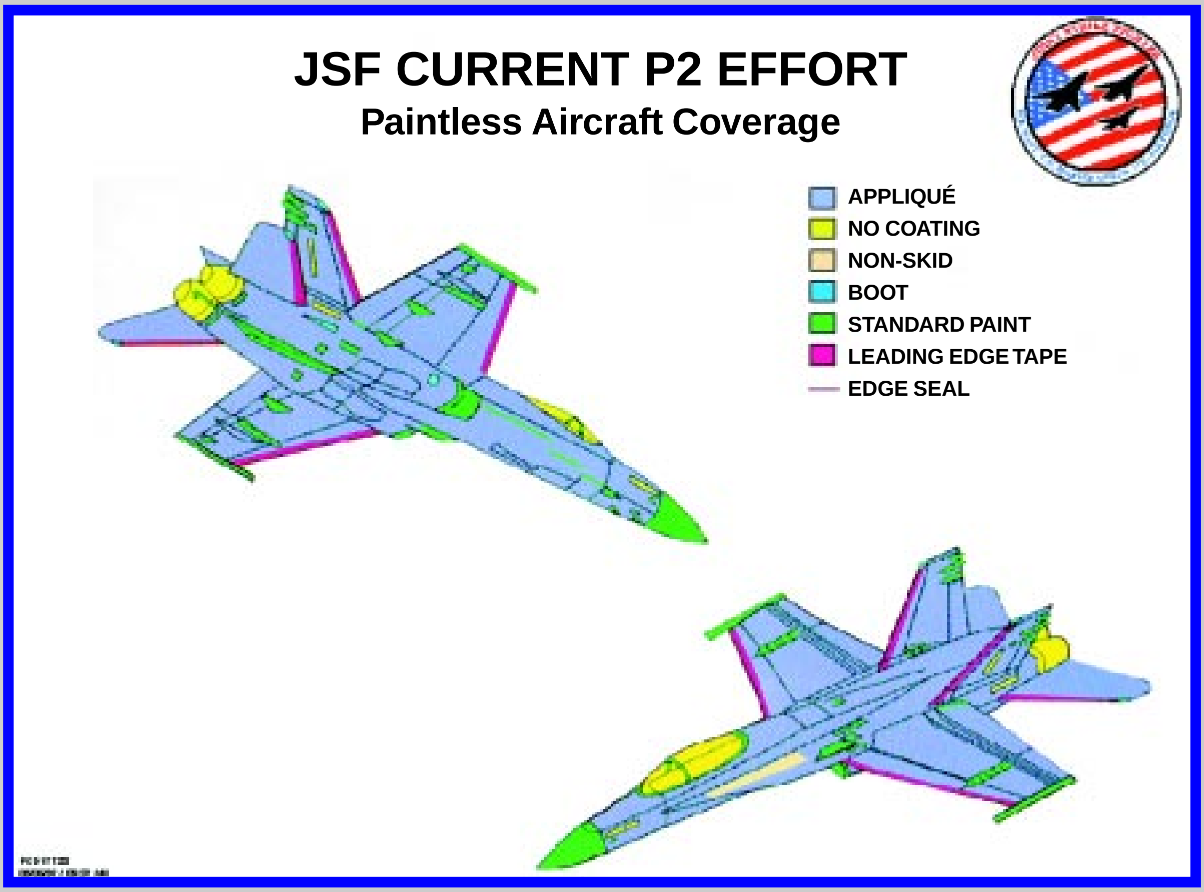
Joint Strike Fighter: New Coating Expected to Drastically Reduce Life Cycle Costs

An estimated 90% of hazardous material costs associated with aircraft maintenance is attributable to the de-painting/repainting processes. The Joint Strike Fighter (JSF) Program is participating in the validation of a paintless aircraft coating system for exterior surfaces, pursued jointly by the U.S. Air Force, the Marine Corps, and the Navy in partnership with Boeing, Lockheed Martin and 3M. The new material, an appliqué made of a fluorinated polymer, was affixed to an F/A-18B chase plane to demonstrate the performance and supportability of the appliqué in a supersonic, carrier-deployable environment. Greater than 80% of the aircraft's surface has received the appliqué and has seen in excess of 100 flight hours, including over two hours at supersonic speeds. The environmental benefits are considerable.

The appliqué has the potential to eliminate:

- The application of high to moderate VOC-laden topcoats and primers.
- Exposure to hexavalent chromium during primer application and the associated medical monitoring and personal protective equipment.
- The requirement for capture technologies, air permits, and paint spraying equipment.
- Environmentally controlled paint facilities.
- Large quantities of blast media or chemical stripper for coatings removal and the associated procurement and waste disposal costs.

Initial estimates predict that operations and support life cycle cost savings may exceed $3 billion USD over the 20-year service life of the Joint Strike Fighter system.



Life Cycle Assessment (LCA)

Life Cycle Assessment (LCA) is a method for making comparisons among products with respect to their environmental impact by examining resource-use and pollution-load of products throughout their life cycles, i.e., from raw material extraction to disposal of the final waste. The word product is used in a broad sense; it could be an object, a service, an industrial process, or anything with a function. Thus, a product comparison is in fact a comparison of alternative ways of obtaining the functions delivered by the products.

A complete LCA covers all stages of the life cycle and all environmental effects. It can be a time-consuming process. It is unlikely that a military acquisition program will have the time or the resources to conduct a detailed LCA for an entire weapon system. Instead, a program office is more likely to use a life cycle thinking process to explore various concepts during the concept development phase of acquisition. As the acquisition program progresses through design, production, and deployment, various options can be assessed using a more conceptual approach to LCA with less detailed and more generic data. This less-detailed analysis is known as a simplified or conceptual LCA.

A simplified LCA is described as an LCA that is carried out in a simplified manner, but without missing any important information. It is used as a label for LCA studies whose main objective is to identify and assess important environmental issues or "hot spots." Since these "hot spots" can be identified and refined at any point in any acquisition program, it is likely that the LCA process will be used numerous times and in nearly every phase of an acquisition program.

The LCA techniques are adapted as ISO standards (ISO 14040-43).

An LCA includes four phases:

1. Goal and Scope Definition Phase
2. Inventory Analysis Phase
3. Impact assessment Phase
4. Interpretation Phase

The steps of an LCA

1. Define the goal and scope

The goal of an LCA study should clearly state the intended application, including the reasons for carrying out the study and the intended audience, i.e., the group that will receive the results of the study.

The scope should be sufficiently defined to ensure that the breadth, the depth, and the detail of the study are compatible and sufficient to address the stated goal. The LCA is an iterative technique. Therefore, the scope of the study may need to be modified while the study is being conducted and as additional information is collected.

2. Conduct an inventory analysis

Inventory analysis involves data collection and calculation procedures to quantify relevant inputs and outputs of a product system. These inputs and outputs may include the use of resources and releases to air, water, and land associated with the system. Interpretations may be drawn from these data, depending on the goal and scope of the LCA. These data also constitute the input to the life cycle impact assessment.

3. Conduct an impact assessment

The impact assessment phase of LCA is

aimed at evaluating the significance of potential environmental impacts using the results of the life cycle inventory analysis. In general, this process involves associating inventory data with specific environmental impacts, and attempting to understand those impacts. The level of detail, choice of impacts evaluated, and methodologies used depends on the goal and scope of the study.

The impact assessment phase may include elements such as, among others:

- assigning of inventory data to impact categories (classification);
- modelling of the inventory data within impact categories (characterisation); and
- possibly aggregating the results in very specific cases and only when meaningful (valuation).

There is subjectivity in the life cycle impact assessment phase such as the choice of impact categories and the weighting across impact categories (i.e., the valuation). Therefore, it is critical to ensure that the assumptions are clearly described and reported.

4. Interpret the findings

Interpretation is the phase of the LCA in which the findings from the inventory analysis and the impact assessment are combined together (or, in the case of life cycle inventory studies, the findings of the inventory analysis only) in line with the defined goal and scope. The findings of this interpretation may take the form of conclusions and recommendations to decision-makers.

Additional information on LCAs can be found at the European Environment Agency LCA web site at **http://tiger.eea.eu.int/Projects/EnvMaST/lca/default.htm**.

References

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Nordic Council of Ministers, 1995, LCA-Nordic, Technical Reports No.10 and Special Reports No. 1-2, Copenhagen.

LCA Screening and Streamlining Working Group, *Simplifying LCA: Just a Cut?* Final Report, Society of Environmental Toxicology and Chemistry (SETAC), Europe.

Control

Hazardous Material Management

Environmental problems have changed in recent decades. Chemical substances are crossing national boundaries in products and goods. Airborne pollutants may impact bordering countries. This situation forms the basis for an intensified international commitment to improve knowledge of the dangers presented by chemical substances to health and the environment, and of ways in which those dangers can be reduced and averted.

International work in the chemicals sector is proceeding mainly under the aegis of the United Nations, the Organisation for Economic Co-operation and Development (OECD) and the European Union, and also under specially framed marine conventions and bilateral agreements. The results of this international work are valuable in assessing the materials and chemical products that should be avoided in connection with acquisition of defence material.

Register of hazardous substances

In order to have control over the hazardous substances that are used in the activities of the military, it is necessary to keep a register of materiel items which contain hazardous substances, as well as any materiel components containing hazardous substances.

Examples of hazardous requisites:

- Chemicals
- Ammunition
- Radioactive components
- Materiel which chiefly consists of a hazardous substance (e.g., fluorescent tubes, batteries)
- Other requisites (an account must be given of any occurrence of hazardous components)

The register can be used to obtain information such as the following on chemical products:

- Inventory of chemical products which are used per organisational unit (e.g., place of work, safety area, unit, whole of the Armed Forces)
- Information on chemical products (e.g., product information, safety sheet, transport card)
- The composition of the chemical product
- Which products contain a particular substance (e.g., cadmium)
- Annual consumption per organisational unit
- Labelling
- Classification
- Which products for example are classified as toxic or flammable
- Where a particular product is used
- Area of use
- Requirements regarding the transporting of a particular product

Substitution

Chemical products that can be replaced by less hazardous ones are to be avoided (the substitution principle). In assessing chemical products, consideration must be given to:

- the properties of the product (health hazard, environmental hazard, volatility, tendency to produce dust, reaction risks, flammability, explosion hazard, technical properties, waste disposal, etc.); and
- quantity, temperature, open or closed handling, ventilation conditions, evaporation surface area, aerosol formation, risk of skin contact and splashes, risk of spark formation, naked flames, etc.

Making the correct product choice necessitates having established purchasing routines, which should include establishing who makes purchasing decisions and what documentation must be produced.

Various types of lists (e.g., IRTC) and international agreements (e.g., the Montreal protocol) can be used to assist in making an assessment.

Hazardous Material Management Checklist

✓	Questions
	• What materials/chemicals are used during manufacturing?
	• Which materials/chemicals are to be used during operation and maintenance?
	• Are the substances regulated?
	• Are there any known environmental hazards concerning the substances?
	• Is it possible that the materials/chemicals can cause environmental hazards in the future?
	• Is it possible to choose a less hazardous substance?
	• Is it possible to choose a less hazardous process?
	• Is it possible to re-use or recover the materials?

Innovative Hazardous Material Management

The Consolidated Hazardous Material Reutilization and Inventory Management Program (CHRIMP) is a U.S. Navy life cycle management program based on centralised control of hazardous materials (HMs). Under CHRIMP, every shore facility and every ship inventories the locations, kinds, and amounts of its HMs and checks this inventory against an authorised materials list. The facility or ship then establishes a central point for obtaining, storing, issuing, reissuing, and eventually disposing of HMs as waste. This process has resulted in higher efficiency in maintenance activities and substantial cost savings by:

- procuring the materials in quantities appropriate for work requirements;
- reducing procurement costs by reissuing partially used containers, thus using less hazardous material; and
- reducing disposal costs by generating less hazardous waste.

In 1993, 10 prototype shore facilities that used CHRIMP showed cost avoidance savings of $7.15 million USD through reduced HM purchases and hazardous waste generation. On the six ships that tested CHRIMP in 1993, reduced purchase and waste generation cost avoidance saved the Navy more than $688,000 USD. CHRIMP has also increased personnel safety and health and improved damage control by removing HMs from individual spaces.

Naval Station Mayport redistributed over $315,000 USD worth of hazardous material that was designated as excess and set for disposal, resulting in a cost avoidance savings of $1.2 million. This was fundamental to Mayport's winning the State of Florida's "Governor's Sterling Award for Quality" in May 1994.

CHRIMP is now being implemented throughout the U.S. Navy, ashore and at sea.

Register of Hazardous Material

The Swedish Armed Forces has developed a computer-based register which includes all the chemical products which are used within the Forces. Information is tracked for all registered chemical products and is accessible to interested personnel, including materiel system managers.

The purpose of the register is to:

- provide an overview of all hazardous material used in the Armed Forces;
- provide information about risks and safety precautions;
- reduce the number of chemicals used;
- provide information on less hazardous substitutions for hazardous chemicals; and
- serve as a tool for the system managers to choose chemicals for maintenance and other purposes.

The chemicals included in the register are screened by an expert group for use by the Armed Forces.

Purchasing and Contracting

General Strategies

There are several general principles that can be used as guidelines for purchasing. Below is short description of the ones we believe are most important.

The Principle of the Cyclic Society

In the cyclic society principle, the flows of various materials within society have been reduced and closed to such extent that the flows from society to the environment do not exceed the limits of sustainability. Reuse and recycling are two ways of limiting our extraction of renewable and non-renewable materials from nature.

The Precautionary Principle

Principle 15 of the Rio Declaration states that, “Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.”

The Substitution Principle

The substitution principle implies that 1) anyone handling substances and products must judge whether the same results can be achieved, at a lower risk, with a different substance or product or in a different way, and that 2) if so, the handler must substitute the substance, product or method concerned.

The Duty of Investigation

The duty of investigation requires manufacturers and importers to investigate and assess the inherent properties of substances or products, to inform users of those properties, and to supply instructions concerning appropriate handling and safety precautions.

The Polluter Pays Principle

The polluter pays principle (PPP) is an environmental-economic principle based on the idea that the environment has a utility value to mankind and must therefore be priced. PPP means the polluter bears the cost of a clean environment (i.e., the inclusion of the environmental cost in the price of products and goods that cause pollution).

In the ministerial declaration from the Bergen Conference in 1990, a resolution was adopted calling for increased introduction of taxes and charges to counteract destruction of the environment.

The Best Available Technology Principle

The best available technology (BAT) principle indicates that the best existing technologies or procedures that can be applied at a reasonable cost should be used for preventing or minimising environmental damage.

Environmental Labelling/Eco-labelling and Environmental Certification

There are different ways a purchaser can get information about the environmental aspects of products and about whether a production process, product, or system is environmentally sound. Eco-labelling compares different products in a product group and points out the most environmentally positive products among these.

The general idea of eco-labelling is to award the label to products that cause less damage to the environment than other similar products. The criteria for different labels can vary significantly. Some labels only consider parts of the environmental impact of a product, while others try to cover as much as possible.

Eco-labels

Blue Angel (Germany)

The German eco-labelling program, Blue Angel, is intended to promote environmentally sound products, relative to others in the same group categories. The criteria for awarding the Blue Angel includes: the efficient use of fossil fuels, alternative products with less of an impact on the climate, reduction of greenhouse gas emission, and conservation of resources. Once approved, these eco-labelled products are reviewed every two or three years to reflect state-of-the-art developments in ecological technology and product design.

Eco Mark (Japan)

The Japanese Environmental Association administrates the Eco Mark Program with the goal of disseminating environmental information on products and encouraging consumers to choose environmentally sound products. This goal will be accomplished by authorising the Eco Mark to be displayed on products that reduce the environmental load caused by everyday activities, thereby contributing to the preservation of the environment. In principle, products must meet the following criteria: impose less environmental load than similar products in their manufacture, use and disposal; and reduce the environmental load in other ways, thus contributing significantly to environmental conservation.

Energy Star (USA)

Energy Star labelling considers the energy consumption of various types of electrical and electronic equipment. Additionally, Energy Star certification is used to designate energy-efficient commercial and residential building designs. Energy Star labelling programs are intended as a means of offering users a choice of products with a lower

Using an Eco-Label for Purchasing Computers

The U.S. Department of Defense (DOD) buys thousands of personal computers every year for use in various weapons acquisition programs as well as in administrative offices. As part of the requirements for each of these procurements, all computers must be energy efficient in order to reduce operation costs and to reduce pollutant emissions such as carbon dioxide, nitrogen oxides, and sulphur oxides caused by burning of fossil fuels at electrical power plants. To ensure that the DOD gets the most efficient products with the least environmental impact, all computers must have the Environmental Protection Agency (EPA) Energy Star certification and label.

environmental impact, since electricity generation accounts for 35% of all U.S. emissions of carbon dioxide, 75% of sulphur dioxide, and 38% of nitrogen oxides.

Environmental Choice (Canada)

The Canadian program helps consumers identify products and services that are less harmful to the environment. A product or service may be certified because it is made or offered in a way that improves energy efficiency, reduces hazardous by-products, uses recycled materials, or because the product itself can be reused. Product manufacturers, importers, or purveyors of services may apply for a license to use the Environmental Choice logo once a guideline containing criteria relevant to the product or service type has been approved. Environmental Choice guidelines are based on the best information available at the time and are upgraded as new information and technology makes higher standards possible.

Agreements granting use of the label, or eco-logo, are renewed annually and continued compliance with the guideline is monitored. Certified products and services must continue to meet all applicable safety and performance standards; specifically, they must be as good in every other respect as is generally expected of that type.

EU-Flower (European Union)

The EU-Flower eco-label is awarded to products that have a reduced impact on the environment. Criteria for acceptance have been set at about 10-20% of brands or models on the market. There is a usually a three-year period of criteria validity after which they will be reviewed and the standards may be raised.

Green Seal (USA)

The Green Seal certification mark identifies those products that are environmentally preferable, empowering consumers to choose products based on their environmental impacts. To date, Green Seal has awarded its approval to 234 products. Green Seal certifies products in over 50 categories including: paints, water-efficient fixtures, bath and facial tissue, re-refined engine oil, printing and writing paper, energy-efficient lighting, paper towels and napkins, household cleaners, energy-efficient windows, and major household appliances.

NF Environment (France)

The NF Environment mark features a single leaf covering a globe. The mark means that the product has less impact on the environment while achieving the same level of service as other products on the market. Industries who wish to highlight their environmental efforts can voluntarily apply to use the NF Environment label on their products. Certification is based on a multi-criteria approach within a number of product categories including paints, garbage bags, and automobile coolants.

Nordic Swan (Nordic Countries)

The aim of the Nordic Swan label is to encourage environmentally sustainable consumption. The labelling is voluntary. It is intended to guide consumers and purchasers toward environmentally conscious acquisitions and to stimulate development of products and services that cause less environmental impact than similar products. The whole life cycle of the product, from raw material to disposal, is studied. The criteria have limited lifetime and are regularly revised.

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The increasing use of eco-labels throughout the world requires harmonisation of the criteria used in eco-labelling. The ISO 14000 series eco-labelling standard will provide requirements for three types of labels. The first type is a “seal of approval” for products that meet specified requirements within a product class. The second type will be a single-claim label for such things as recycled content, energy efficiency, etc. The third type will be an “environmental report card” that uses a life cycle approach and allows comparison of the environmental effects of manufacturing and use.

Eco-Labelling At a Glance

Symbol	Name	Country or Region	Since	Number of Products and Groups of Products
	Blue Angel	Germany	1977	4,000 Products 71 Groups of Products
	Eco Mark	Japan	1989	68 Groups of Products
	Energy Star	USA	1992	Computers, Office Equipment, Heating & Cooling Equipment, Televisions and VCRs, Lighting, Buildings, Signs, Transformers.
	Environmental Choice Program	Canada	1988	1,400 Products 47 Groups of Products
	EU Flower	European Union	1977	12 Groups of Products
	Green Seal	USA	1990	234 Products 50+ Groups of Products
	NF Environment	France	1991	250 Products 6 Groups of Products
	Nordic Swan	Nordic Countries	1989	1,500 Products 47 Groups of Products

Contracting Tools

International treaties, national legislation and other regulations limit the freedom of action for militaries when purchasing weapon systems. The regulations vary between countries; therefore, it is imperative to ensure that a procedure or a piece of advice given in this handbook is consistent with national legislation and policies.

In the U.S., purchasing of defence equipment is primarily regulated by Federal Acquisition Regulations (FAR), Federal Acquisition Streamlining Act of 1994 (FASA), and Federal Acquisition Reform Act of 1995 (FARA) with instructions and Department of Defense (DOD) directives and instructions. In addition, there are Army, Navy, Marine Corps and Air Force policies.

In the European Union (EU), the Treaty of Rome is fundamental to the distribution of competence among the Union and its member states. The Treaty decrees that the inner market will comprise an area without inner borders, where free trade is available for goods, persons, services, and capital. In general, there are two exceptions. They are:

1. Purchase of goods with regard to national security (article 36)
2. Products intended specifically for military purposes (article 223)

Rules for public purchasing inside the EU are given in a large number of EU Directives and in related laws.

The principle of free movement of goods and the EU Directives regarding public purchasing are most relevant to acquisition of defence equipment. Those products specifically made for military purposes, which are noted on a special list, are exempted exclusively from the rules of free movement for goods within the Union. Military necessities like fuel, foodstuffs, transport and communications equipment, and other "dual-use" products are by definition not made for military purposes. Hence, they should be objects for free movement and should be purchased according to the main rules for public purchasing within the EU. However, small purchases (not exceeding specified limit values) are exempted. The regulations imply that all manufacturers within the states of the Union will have the right to submit tender. Domestic manufacturers must not be favoured over those of other nations.

The states of the Union have undertaken to comply with the Treaty of Rome, the Court of Justice, and the decisions of the Council of the European Union in their national legislation. Since the European Community Law does not rule purchasing of goods for military purposes, each member state is allowed to impose additional regulations. These regulations can refer to how to design request for proposal, purchasing strategy, the right to negotiate with a vendor/tenderer and criteria for awarding contracts.

States outside the EU are sovereign within the constraints by concluded treaties to design rules for purchasing weapons and military equipment.

Addressing Environmental Considerations in Contracts

Environmental considerations by development phase and acquisition type were discussed earlier in this handbook. This section provides general information on how to integrate those considerations in the contract process. Additionally, this section provides simple examples to allow the program manager to develop environmental contract language in the best interest of the program.

Activities Before Request for Proposal

Prior to the preparation of the request for proposal (RFP), the potential environmental issues associated with the weapon system to be procured must be understood. If the issues are not well known, information should be obtained through market investigation or, if necessary, through a request for information from potential bidders. After the potential environmental impacts are understood, environmental language can be developed to incorporate into the RFP.

Request for Proposal

The RFP must incorporate environmental requirements such as technical evaluation factors, standards, statement of objective, and a system requirements document. National Aerospace Standard 411 is a document that provides ideas on how these requirements may be incorporated. It is critical that specifications and standards are screened in any new RFP for references to ozone-depleting substances and banned/unacceptable hazardous materials. In addition, source-selection criteria can be used to capitalise on a contractor's ability to provide innovations that help the defence department meet its environmental goals. Finally, the contract language may include incentives such as "award fee plans" to reward contractors for innovation and successfully meeting or beating the environmental goals.

Sample Methods of Incorporating Environmental Requirements in Contracts

General Environmental Requirements

It can be convenient to summarise environmental requirements that are not covered elsewhere in the contract under a specific heading. The text under this heading should include general language requiring that hazardous material use or generation be minimised during production, operation, or maintenance of the weapon system. When this method is used, is it generally preferable to require the contractor to develop a metric to allow for some measurable way to judge the effectiveness of the minimisation effort. Other examples of general requirements may include statements regarding the use of recycled materials, recyclability of end product components, or reduction in life cycle cost.

Requirements on the Product

If specific environmental performance requirements are known for the product, they should be stated explicitly in the contract. This can be as simple as providing a list of materials that are prohibited during all or any specified portion of the weapon system's life cycle. Examples of other specific requirements may be limits for emissions such as noise, radiation, and exhaust gases. In this case, the limit can be specified quantitatively, or the contractor can be required to ensure emissions meet the requirement of a specific environmental law.

Requirements for Contractors

Acquisition programs conducted by the U.S. Department of Defense require the weapon system contractor to implement a Hazardous Materials Management Program. One way to accomplish this is to use the National Aerospace Standard (NAS) 411. The purpose of the Hazardous Material Management Program, as stated in NAS 411, is to ensure that adequate consideration is given to the elimination or reduction of hazardous materials used or generated by the system being analysed throughout its life cycle.

NAS 411 provides a flexible, systematic process for managing hazardous materials in the acquisition and life cycle of a system. The standard helps reduce hazardous materials usage and the generation of pollutants, not only during the manufacture, but also during the operations and maintenance, of the system over its life cycle. NAS 411 provides a uniform method for the contractor to identify all hazardous materials and to manage, minimise, and eliminate them wherever possible. A critical element of NAS 411 is the requirement of progress reports from the contractor detailing:

- Lists of hazardous materials the contractor must use because of military specifications and standards;
- Lists of hazardous materials the contractor must use because no alternative technology exists to meet performance requirements; and
- Trade-off analyses to determine alternatives that decrease environmental liabilities and decrease costs.

Sources of Information

Defence Information

DENIX

The Defense Environmental Network and Information eXchange (DENIX) is an electronic bulletin board system that facilitates the exchange of information and ideas among defence ministry professionals worldwide. The DENIX system serves as a centralised communication platform, allowing for dissemination of policy and guidance, access to information sources, and transmission of data up and down the command chain.

DENIX on the WEB! provides timely access to information on:

- Legislation and regulations
- Compliance
- Pollution prevention
- Natural and cultural resources
- Safety and health
- Environmental publications
- Training and conferences

Find *DENIX on the Web!* at **http://www.denix.osd.mil**.

The U.S. Department of Defense Acquisition Deskbook

The Defense Acquisition Deskbook is an electronic reference system designed specifically for acquisition professionals. The Deskbook includes the various functions, disciplines, activities, and processes beginning with “user” input, and potentially flowing through concept development, program establishment, contracting, testing, production, sustainment, and ending with recovery or recycling. In clear terms, the Deskbook is the sequential organisation of events and activities that, when followed, result in the completion of an acquisition/sustainment process.

The Deskbook takes all the acquisition activities and links them to their specific reference

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citations (both mandatory and discretionary), pertinent training courses, lessons learned, software tools, and front-line wisdom and advice.

The Defense Acquisition Deskbook originated from an Acquisition Reform Initiative to reduce directives. The Deskbook assists managers in making informed environmental decisions by supplying a large volume of information on environmental considerations in the acquisition process. The Deskbook is available online at the web site **http://www.deskbook.osd.mil**.

The Swedish Armed Forces

Information on the environmental policy, management system, projects, etc., in the Swedish Armed Forces is available on the environmental sections home page at **http://www.mil.se/hkv/miljosek/miljo_e.html**.

National Information Sources

National environmental authorities also provide information on environmental issues. In many cases, they have web sites with a lot of useful information and environmental links. Examples are the U.S. Environmental Protection Agency (**www.epa.gov**) and the Swedish Environmental Protection Agency (**www.environ.se**). On these pages, it is possible to find information on projects, programs, publications, laws and regulations, etc.

International Information Sources

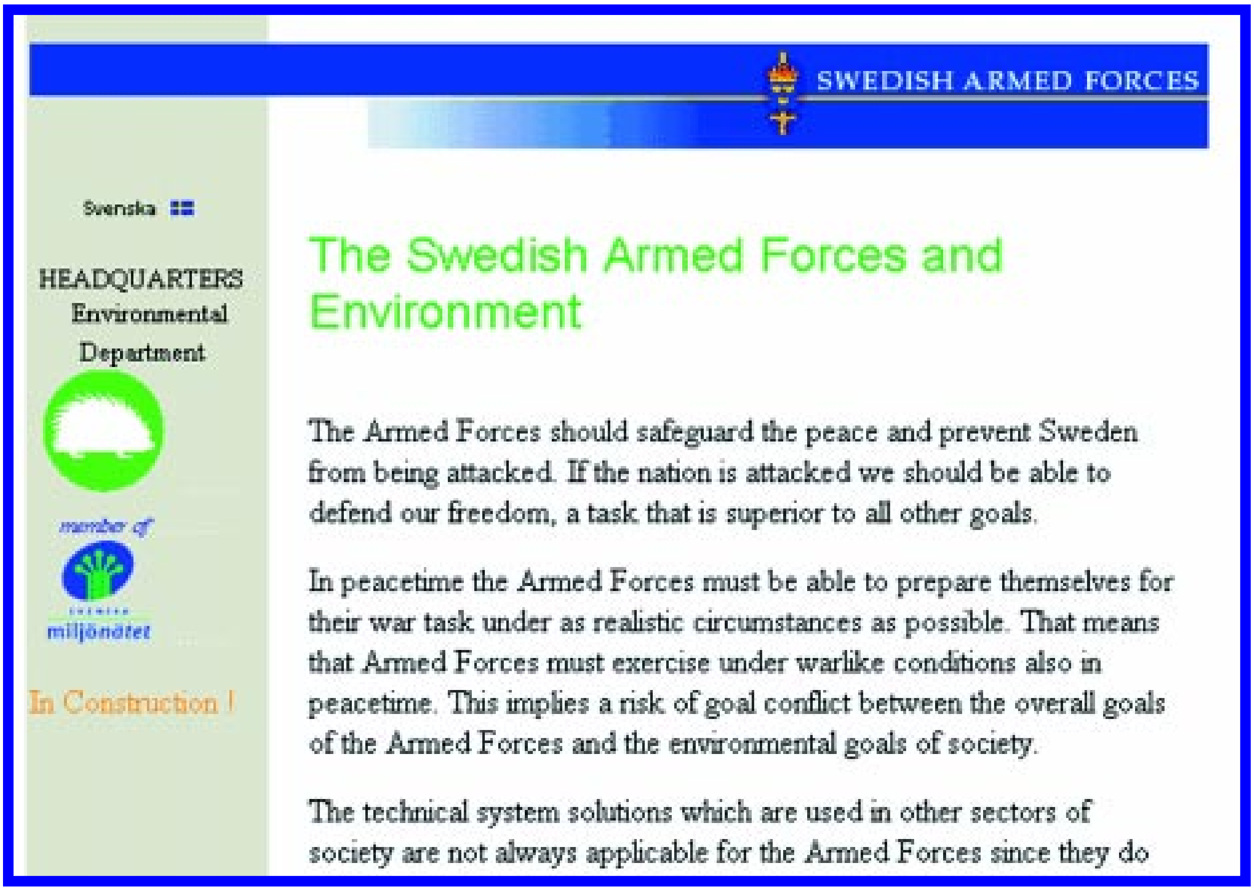
The European Union (EU)

The European Environment Agency (EEA) has been set up to supply the EU and the Member States with objective, dependable, and comparable data on European environmental conditions. The Agency, in which non-member States can also take part, is expected to become an important instrument of EU environmental policy work in the future. Information on EEA, events, projects, etc., is available on the EEA web site at **http://www.eea.dk**.

The Organisation for Economic Co-operation and Development (OECD)

On the subject of environment, the OECD is a forum of discussion and information interchange and is above all a consensus body. Many agreements within the OECD are informal and unpublished. If member countries so desire, the

▲ DENIX Web Page ▼ Swedish Armed Forces Web Page



OECD Council has certain procedures for adopting common standpoints. A Council Act is legally binding, whereas a Council Decision/Recommendation implies a strong moral obligation.

Information on environmental issues is available on the OECD web site at **http://www.oecd.org/env**.

United Nations Environment Programme (UNEP)

UNEP's mandate is to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations to improve their quality of life without compromising that of future generations.

On UNEP's web site (**www.unep.org**), information is available on, among other things, international conventions concerning the environment such as:

- Basel Convention on Transboundary Movement of Hazardous Wastes
- Convention on Biological Diversity
- Convention on Climate Change
- Convention to Combat Decertification
- Convention on International Trade in Endangered Species
- Montreal Protocol and Vienna Convention

List of Acronyms

CARC .... Chemical Agent Resistant Coating
CFC .... Chlorofluorocarbon
CRT .... Cathode Ray Tube
DENIX .... Defense Environmental Information Exchange
DOD .... Department of Defense
EIA .... Environmental Impact Assessment
EIS .... Environmental Impact Statement
EMAS .... Eco-Management and Audit Scheme
EMS .... Environmental Management System
EPA .... Environmental Protection Agency
EU .... European Union
HC .... Hydrocarbon
HM .... Hazardous Material
ICAO .... International Civil Aviation Organisation
IMO .... International Maritime Organisation
ISO .... International Organisation for Standardisation
LCA .... Life Cycle Assessment
LCC .... Life Cycle Cost
MARPOL .... Maritime Pollution Protocol
NAMSA .... NATO's Maintenance and Supply Agency
NAS .... National Aerospace Standard
NATO .... North Atlantic Treaty Organisation
NO_x .... Nitrogen Oxides
OCCAR .... Organisme Conjoint De Coopération En Matière D'Armement
ODS .... Ozone-Depleting Substance
OECD .... Organisation for Economic Co-operation and Development
PCB .... Polychlorinated Biphenyls
PESHE .... Programmatic Environmental, Safety and Health Evaluation
PFC .... Perfluorocarbon
PM .... Particulate Matter
PMT .... Program Management Team
PVC .... Polyvinyl Chloride
RFP .... Request For Proposal
SEA .... Strategic Environmental Assessment
SO_x .... Sulphur Oxides
UNEP .... United Nations Environment Programme
U.S. .... United States
USD .... U.S. Dollars
VOC .... Volatile Organic Compound
WEAO .... Western European Armaments Organisation
WWW .... World Wide Web